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ABSTRACT

This teacher's guide contains 14 units on snowmobile repair: (1) introduction to snowmobile repair; (2) skis, front suspension, and steering; (3) drive clutch; (4) drive belts; (5) driven clutch; (6) chain drives; (7) jackshafts and axles; (8) rear suspension; (9) tracks; (10) shock absorbers; (11) brakes; (12) engines; (13) ignition and electrical systems; and (14) storage. Each unit includes all or some of the following: performance objectives, suggested activities for teachers and students, information sheets, assignment sheets, job sheets, transparency masters, tests, and answers to the tests. Units are planned for more than one lesson or class period of instruction. An instructional task analysis provides listings of cognitive and psychomotor tasks for each of the 14 units. A listing is provided of the needed hand tools, shop tools, safety and first aid equipment, miscellaneous tools and supplies, test equipment, and special tools and supplies. A 24-item reference list is included. (CML)

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Snowmobile Repair

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MID-AMERICA VOCATIONAL CURRICULUM CONSORTIUM

Teacher Edition

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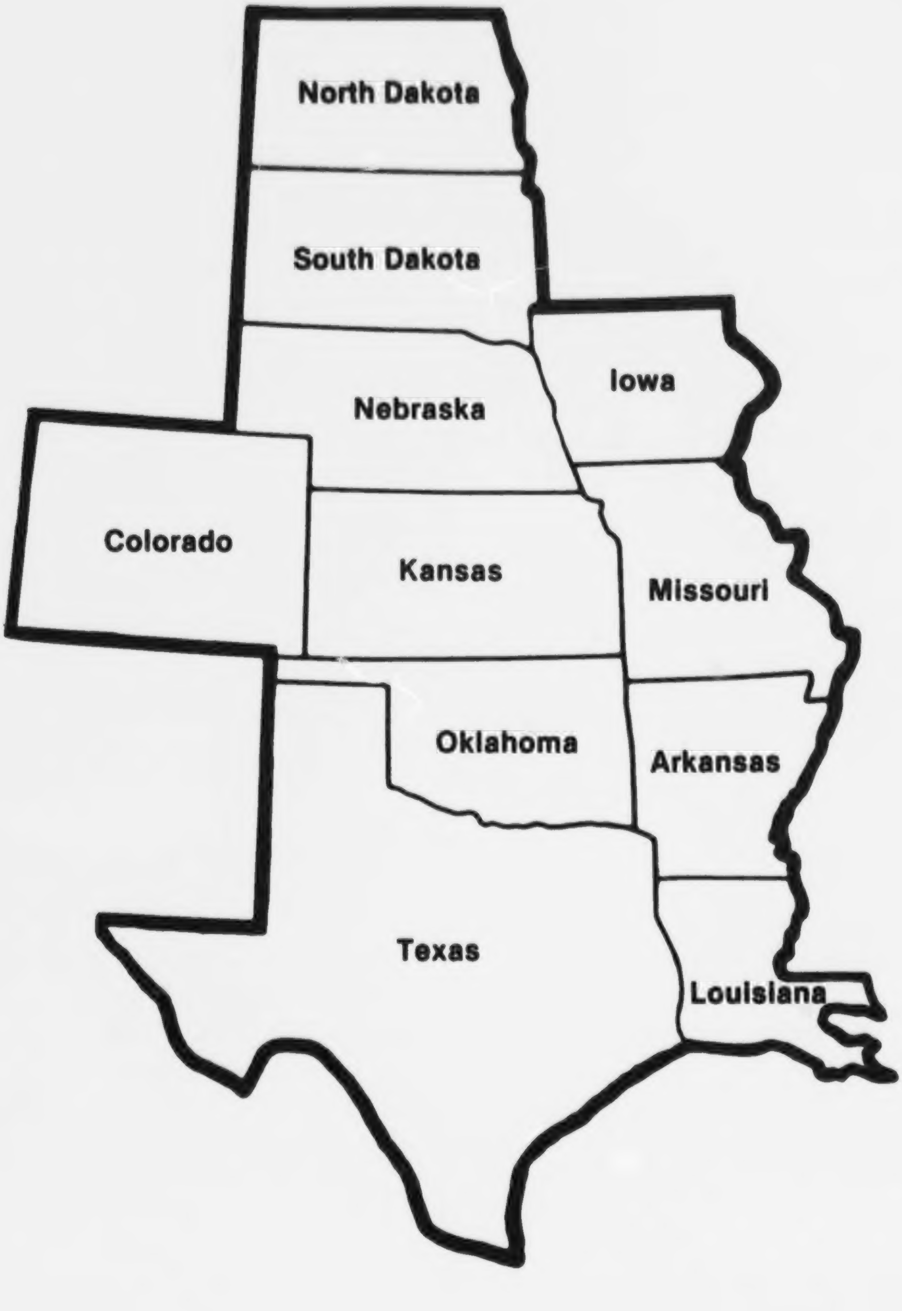
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SNOWMOBILE REPAIR

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SNOWMOBILE REPAIR

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FOREWORD

This text set out to be a revision of MAVCC's 1976 publication, *Snowmobile Repair*, and quickly snowballed (no pun intended) into a brand new book. We say brand new because of the addition of many materials that did not appear in the original text. Materials covering engine service, ignition and electrical troubleshooting, and storage help make this new text a much more comprehensive effort. The expanded treatment of the unique variable clutch in snowmobiles is another welcome addition, and the entire text has significant graphic additions such as exploded views and photographs to enhance its usefulness.

We naturally thank Wayne Helbling of Mandan, North Dakota, for the original text, but we point with pride to this new book and thank Stephen Hennessey of Alaska, and Rex Conrad of South Dakota, for helping write these materials. Stephen teaches small engine repair at Wasilla High School in Wasilla, Alaska, and Rex teaches motorcycle technology and snowmobile repair at Western Area Vo-Tech Institute in Rapid City, South Dakota. Needless to say, both instructors live in the snowbelt and know their snowmobiles.

The snowmobile serves many purposes; for many it's a recreation vehicle. Others race snowmobiles while some people put them to work. But in the heavy snow areas where winter passage is denied other vehicles, the snowmobile is a life saver. In short, the snowmobile is a multi-purpose vehicle that requires special service, and that is what *Snowmobile Repair* is dedicated to.

Bob Patton, Chairman
Board of Directors
Mid-America Vocational
Curriculum Consortium

PREFACE

MAVCC's constant attention to format improvement is evident in every unit of *Snowmobile Repair.* The use of exploded views in transparency masters help show students important relationships that other types of line art would not accomplish. The use of photographs to enhance the step-by-step procedures is another effort to add work-place realism to the instructional process. We think the added graphic impact will make this book more interesting for students and enhance the teaching value of the text for instructors.

We might mention too that *Snowmobile Repair* has some other fine texts for company in MAVCC's small engine repair series. These texts include *Small Engine Repair: Two-Stroke and Four-Stoke Cycle, Chain Saw Repair, Outdoor Power Equipment Repair, Outboard Repair,* and a brand new *Motorcycle Repair.* In other words, MAVCC's big on small engines. Keep us in mind.

Greg Pierce
Executive Director
Mid-America Vocational
Curriculum Consortium

ACKNOWLEDGEMENTS

In addition to writers and editors, it takes many other people to help develop a good text book. *Snowmobile Repair* owes a thank you to many people, especially the committee that helped plan and validate the text. This group includes:

Mike Emberty	Ft. Collins Cycle Center, Ft. Collins, Colorado
Kenneth Powers	Vocational Curriculum Development and Research Center, Natchitoches, Louisiana
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Kevin Hartley	American Honda Motor Company, Inc., Irving, Texas
Jerry Johnson	American Suzuki, Dallas, Texas
Ken Lizotte	Kawasaki Motors Corp., U.S.A., Irvine, California

The writers, Stephen S. Hennessy of Alaska, and Rex Conrad of South Dakota deserve special thanks for their dedication to the project. For assistance with writing and research, thanks to Rob Dean, and for photography, thanks to Dan Fulkerson.

Special appreciation is extended to Kawasaki Motors Corp., U.S.A., and their National Training Manager, Ken Lizotte. Although Kawasaki no longer markets snowmobiles, their shop manuals provided many of the illustrations that have helped enhance this text.

Appreciation is also extended to Yamaha Motor Corporation, U.S.A., and their Service Training Manager, Dennis Hendrix for sending valuable reference materials, and to those from other companies who contributed their time in telephone consultations and also provided excellent reference materials: Bryce Abrhamson from Arctic Cat in Thief River Falls, Minnesota; D. Roy of Bombardier, Ltd., in Valcourt, Quebec, Canada; and Dick Arneson and Norm Berg of Polaris in Roseau, Minnesota.

A special note of appreciation is also extended to the Department of Education, State of Alaska, for supplemental development funding, and to the Coordinator of Career and Vocational Education, Verdell Jackson, for his personal attention to paperwork matters that made everything happen.

A final thank you goes to Leslie Mathis, the phototypesetter who put it all together, and to the Oklahoma Vo-Tech Print Shop personnel for the fine job of printing the text.

USE OF THIS PUBLICATION

Instructional Units

Snowmobile Repair contains fourteen units. Each instructional unit includes some or all of the basic components of a unit of instruction; performance objectives, suggested activities for teachers and students, information sheets, assignment sheets, job sheets, visual aids, tests, and answers to the tests. Units are planned for more than one lesson or class period of instruction.

Careful study of each instructional unit by the teacher will help to determine:

A. The amount of material that can be covered in each class period
B. The skills which must be demonstrated

    1. Supplies needed
    2. Equipment needed
    3. Amount of practice needed
    4. Amount of class time needed for demonstrations

C. Supplementary materials such as pamphlets or filmstrips that must be ordered
D. Resource people who must be contacted

Objectives

Each unit of instruction is based on performance objectives. These objectives state the goals of the course, thus providing a sense of direction and accomplishment for the student.

Performance objectives are stated in two forms: unit objectives, stating the subject matter to be covered in a unit of instruction; and specific objectives, stating the student performance necessary to reach the unit objective.

Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the intent of the objectives. A limited number of performance terms have been used in the objectives for this curriculum to assist in promoting the effectiveness of the communication among all individuals using the materials.

Reading of the objectives by the student should be followed by a class discussion to answer any questions concerning performance requirements for each instructional unit.

Teachers should feel free to add objectives which will fit the material to the needs of the students and community. When teachers add objectives, they should remember to supply the needed information, assignment and/or job sheets, and criterion tests.

Suggested Activities for the Instructor

Each unit of instruction has a suggested activities sheet outlining steps to follow in accomplishing specific objectives. Duties of instructors will vary according to the particular unit; however, for best use of the material they should include the following: provide students with objective sheet, information sheet, assignment sheets, and job sheets; preview filmstrips, make transparencies, and arrange for resource materials and people; discuss unit and specific objectives and information sheet; give test. Teachers are encouraged to use any additional instructional activities and teaching methods to aid students in accomplishing the objectives.

Information Sheets

Information sheets provide content essential for meeting the cognitive (knowledge) objectives in the unit. The teacher will find that the information sheets serve as an excellent guide for presenting the background knowledge necessary to develop the skill specified in the unit objective.

Students should read the information sheets before the information is discussed in class. Students may take additional notes on the information sheets.

Transparency Masters

Transparency masters provide information in a special way. The students may see as well as hear the material being presented, thus reinforcing the learning process. Transparencies may present new information or they may reinforce information presented in the information sheets. They are particularly effective when identification is necessary.

Transparencies should be made and placed in the notebook where they will be immediately available for use. Transparencies direct the class's attention to the topic of discussion. They should be left on the screen only when topics shown are under discussion.

Assignment Sheets

Assignment sheets give direction to study and furnish practice for paper and pencil activities to develop the knowledge which is a necessary prerequisite to skill development. These may be given to the student for completion in class or used for homework assignments. Answer sheets are provided which may be used by the student and/or teacher for checking student progress.

Job Sheets

Job sheets are an important segment of each unit. The instructor should be able to demonstrate the skills outlined in the job sheets. Procedures outlined in the job sheets give direction to the skill being taught and allow both student and teacher to check student progress toward the accomplishment of the skill. Job sheets provide a ready outline for students to follow if they have missed a demonstration. Job sheets also furnish potential employers with a picture of the skills being taught and the performances which might reasonably be expected from a person who has had this training.

Test and Evaluation

Paper-pencil and performance tests have been constructed to measure student achievement of each objective listed in the unit of instruction. Individual test items may be pulled out and used as a short test to determine student achievement of a particular objective. This kind of testing may be used as a daily quiz and will help the teacher spot difficulties being encountered by students in their efforts to accomplish the unit objective. Test items for objectives added by the teacher should be constructed and added to the test.

Test Answers

Test answers are provided for each unit. These may be used by the teacher and/or student for checking student achievement of the objectives.

SNOWMOBILE REPAIR

INSTRUCTIONAL TASK ANALYSIS

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)

UNIT I: INTRODUCTION TO SNOWMOBILE REPAIR

1. Terms and definitions
2. Snowmobile history
3. Contemporary snowmobiles
4. Snowmobile types and their uses
5. Modern snowmobile components
6. Snowmobile chassis systems
7. Snowmobile engine systems
8. Snowmobile drive systems
9. Snowmobile track systems
10. Snowmobile suspension systems
11. General snowmobile operator safety
12. Solve problems related to snowmobile operator and repair safety (Assignment Sheet #1)

UNIT II: STEERING, FRONT SUSPENSION, AND SKIS

1. Terms and definitions
2. Steering mechanisms
3. Ski alignment
4. Front suspensions
5. Leafspring front suspension
6. Independent front suspension
7. Strut suspension

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
	8. Comparisons of front suspension systems
	9. Skis
	10. Ski inspection
11. Solve problems related to skis and steering (Assignment Sheet #1)	
12. Remove, inspect, and replace tie rods (Job Sheet #1)	
13. Remove and replace ski skegs (Job Sheet #2)	
14. Adjust ski alignment on a snowmobile (Job Sheet #3)	

UNIT III: DRIVE CLUTCH

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
	1. Terms and definitions
	2. Drive clutch components
	3. Power theory
	4. Clutch wear
	5. Lubricating and cleaning
	6. Clutch adjustment
	7. Troubleshooting
	8. Special tools
	9. Clutch timing
10. Solve problems related to clutch wear (Assignment Sheet #1)	
11. Remove, inspect, and replace a drive clutch (Job Sheet #1)	

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)

RELATED INFORMATION: What the Worker Should Know (Cognitive)

UNIT IV: DRIVE BELTS

1. Terms and definitions
2. Drive belt principles
3. Drive belt installation
4. Causes of drive belt failure
5. Transmission and drive belt relationships
6. Drive belt alignment
7. Drive belt manufacturers
8. Troubleshooting belt failures
9. Solve problems related to drive belts and transmissions (Assignment Sheet #1)
10. Remove and install a drive belt (Job Sheet #1)

UNIT V: DRIVEN CLUTCH

1. Terms and definitions
2. Parts of a driven clutch
3. Transmission principles
4. Driven clutch principles
5. Driven clutch operations
6. Clutch types
7. Drive clutch/driven clutch relationships
8. Adjusting offset
9. Adjusting center distance
10. Adjusting parallelism

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
11. Solve problems related to transmission principles (Assignment Sheet #1)	
12. Disassemble a driven clutch (Job Sheet #1)	
13. Reassemble a driven clutch (Job Sheet #2)	

UNIT VI: CHAIN DRIVES

JOB TRAINING	RELATED INFORMATION
	1. Terms and definitions
	2. Parts of a chain case
	3. Silent chains
	4. Detachable drive chains
	5. Causes of chain failure
	6. Chain drive troubleshooting
7. Solve problems related to chain drives (Assignment Sheet #1)	
8. Remove, inspect, and replace a drive chain (Job Sheet #1)	
9. Repair a detachable chain (Job Sheet #2)	

UNIT VII: JACKSHAFTS AND AXLES

JOB TRAINING	RELATED INFORMATION
	1. Terms and definitions
	2. Components of a drive axle assembly
	3. Types of axles
	4. Axle repair
5. Solve problems related to axle repair and maintenance (Assignment Sheet #1)	

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
6. Remove and install a jackshaft (Job Sheet #1)	
7. Disassemble a drive axle assembly (Job Sheet #2)	
8. Reassemble a drive axle assembly (Job Sheet #3)	

UNIT VIII: REAR SUSPENSION

	1. Terms and definitions
	2. Slide rail suspension systems
	3. Components of a slide rail suspension
	4. Maintenance
5. Solve problems related to rear suspension maintenance (Assignment SHeet #1)	
6. Disassemble and reassemble a slide rail suspension (Job Sheet #1)	
7. Replace wear strips (Job Sheet #2)	

UNIT IX: TRACKS

	1. Terms and definitions
	2. Types of tracks
	3. Causes of track failure
	4. Track tension and alignment
	5. Steps in track tension alignment
	6. Singeing a track
7. Solve problems related to track maintenance (Assignment Sheet #1)	

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
8. Remove and replace a track (Job Sheet #1)	
9. Adjust track tension and alignment (Job Sheet #2)	
10. Singe a track (Job Sheet #3)	
11. Replace track guide clips (Job Sheet #4)	
UNIT X: SHOCK ABSORBERS	
	1. Terms and definitions
	2. Location of shock absorbers
	3. Purposes of shock absorbers
	4. Types of shock absorbers
	5. Shock absorber inspection
6. Solve problems related to snowmobile shock absorbers (Assignment Sheet #1)	
7. Remove and replace an oil-filled shock absorber (Job Sheet #1)	
8. Adjust spring preload (Job Sheet #2)	
UNIT XI: BRAKES	
	1. Terms and definitions
	2. Parts of a typical disc brake unit
	3. Parts of a typical hydraulic brake unit
	4. Types of snowmobile brakes
	5. Maintenance
	6. Brake fluid

JOB TRAINING: What the Worker Should Be Able to Do
(Psychomotor)

RELATED INFORMATION: What the Worker Should Know
(Cognitive)

7. Solve problems related to maintenance of brake systems (Assignment Sheet #1)

8. Disassemble and reassemble a disc brake (Job Sheet #1)

9. Adjust a disc brake (Job Sheet #2)

10. Bleed a hydraulic brake unit (Job Sheet #3)

UNIT XII: ENGINES

1. Terms and definitions
2. Engine history
3. Two-stroke engine design
4. Snowmobile cooling systems
5. Components of a liquid-cooled system
6. Advantages of a liquid-cooled system
7. Lubrication systems
8. Types of carburetors
9. Fuel pumps
10. Cold start methods
11. Coolant/antifreeze
12. Guidelines for engine service

13. Solve problems related to engine maintenance (Assignment Sheet #1)

14. Service a float-type carburetor (Job Sheet #1)

15. Synchronize an oil pump with a carburetor (Job Sheet #2)

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
UNIT XIII: IGNITION AND ELECTRICAL SYSTEMS	
	1. Terms and definitions
	2. Snowmobile electrical requirements
	3. Battery ignition systems
	4. Battery service
	5. Magneto ignition systems
	6. Capacitor discharge ignition systems
	7. Components and their functions
	8. CDI operations
	9. Safety features in a CDI system
	10. Spark plug service
	11. How to use spark plug wear as troubleshooting guidelines
	12. Recoil starter service
	13. Servicing the electrical system
14. Remove, inspect, service, and replace a snowmobile battery (Job Sheet #1)	
15. Remove and inspect ignition coil leads (Job Sheet #2)	
16. Remove, inspect, and test spark plugs (Job Sheet #3)	
17. Troubleshoot a snowmobile electrical system (Job Sheet #4)	
18. Service a recoil starter (Job Sheet #5)	
UNIT XIV: STORAGE	
	1. Terms and definitions
	2. Cleaning

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
	3. Engine preparation
	4. Battery preparation
	5. Drive train preparation
	6. Lubrication and storage
	7. Removing a snowmobile from storage
8. Solve problems related to snowmobile storage	
9. Prepare a snowmobile for summer storage (Job Sheet #1)	

SNOWMOBILE REPAIR

TOOLS, EQUIPMENT, AND MATERIALS LIST

Hand tools

Standard screwdriver set
Phillips screwdriver set
Allen wrench set
Nutdriver set
Combination wrench set
Adjustable wrenches
Slip-joint pliers
Locking jaw (vise-grip) pliers
Needlenose pliers
Diagonal (sidecutting) pliers
Internal and external snap-ring pliers
Ball peen hammer
Soft-faced hammer
Chisel set
Punch set
Drive socket set
Ratchet socket set
Tape measure

Shop tools

Compressed air supply
Wet/dry shop vacuum
File set
Hacksaw and extra blades
Pry bar
Heavy duty drill
Drill bit set (steel)
Soldering gun and solder
Level
Drill press
Bench grinder
Propane torch
Torque wrench
Straightedge

Safety and First Aid Equipment

Fire extinguishers
First aid kit
Eye wash station

Miscellaneous tools and supplies

Drop cloth
Inspection light
Electrical tape
Clean shop towels
Cleaning solvent
Small funnel
Catch pan

Test Equipment

Volt-Ohmmeter (multimeter)
Digital VOM
CDI tester

Special tools and supplies

Track clip tool
Clutch alignment tool
Drive clutch puller
High temperature lubricant
Liquid gasket

ALPHABETICAL LIST OF REFERENCES USED IN DEVELOPING THIS TEXT

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INTRODUCTION TO SNOWMOBILE REPAIR

UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to discuss highlights in snowmobile history, identify components of modern snowmobiles, and discuss systems and their functions on a snowmobile. The student should also be able to list guidelines for operator and repair safety and solve problems related to snowmobile safety. These competencies will be evidenced by correctly performing the procedures outlined in the assignment sheet and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to snowmobile repair with their correct definitions.
2. Complete statements concerning snowmobile history.
3. Select true statements concerning contemporary snowmobiles.
4. Match snowmobile types with their uses.
5. Identify modern snowmobile components.
6. Select true statements concerning snowmobile chassis systems.
7. Complete statements concerning snowmobile engine systems.
8. Complete statements concerning snowmobile drive systems.
9. Select true statements concerning snowmobile track systems.
10. Complete statements concerning snowmobile suspension systems.
11. Complete statements concerning general snowmobile operator safety.
12. Select true statements concerning general snowmobile repair safety.
13. Solve problems related to snowmobile operator and repair safety. (Assignment Sheet #1)

INTRODUCTION TO SNOWMOBILE REPAIR
UNIT I

SUGGESTED ACTIVITIES

A. Provide students with objective sheet.

B. Provide students with information sheet.

C. Make transparency.

D. Discuss unit and specific objectives.

E. Dicuss information sheet.

F. Invite a local snowmobile dealer to talk to the class about dealerships, the seasonal nature of snowmobiling and how it affects repair work, and generally the opportunities in snowmobile repair.

G. Invite a local snowmobile repair person to talk to the class about skills required to be successful in the business, what other activities are required to make up for the off season, and generally the good and bad parts of the business.

H. Invite the president or a member of a local snowmobile club to talk to the class about local snowmobile trails and other activities that are taking place to promote safe snowmobiling in the area.

I. Give test.

CONTENTS OF THIS UNIT

A. Objective sheet

B. Information sheet

C. Transparency Master 1 — Parts of a Snowmobile

D. Assignment Sheet #1 — Solve Problems Related to Snowmobile Operator and Repair Safety

E. Answers to assignment sheets

F. Test

G. Answers to test

REFERENCES USED IN DEVELOPING THIS UNIT

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B. *Snowmobiling Fact Book.* Fairfax, VA: International Snowmobiling Association, 1974.

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G. Malo, J.W. "The Men Who Invented the Machines." *Snowmobiling: The Guide.* New York, NY: Collier Books, 1971.

H. *Snowmobiler's Safety Handbook.* Fairfax, VA 22030: International Snowmobile Industry Association, 1978.

(NOTE: Copies of the Snowmobiler's Safety Handbook are available for a nominal price from the ISIA at the address listed below, and the association can be reached by telephone at 703-273-9606.)

International Snowmobile Industry Association
3975 University Drive
Suite 310
Fairfax, VA 22030

INTRODUCTION TO SNOWMOBILE REPAIR
UNIT I

INFORMATION SHEET

I. **Terms and definitions**

  A. ISIA (International Snowmobile Industry Association) — A group dedicated to promoting the safe manufacture and use of snowmobiles all over the world

  B. ISC (International Snowmobile Club) — A group dedicated to promoting the ownership and enjoyment of snowmobiles for recreational purposes

  C. SSCC (Snowmobile Safety and Certification Committee) — A group that maintains manufacturing standards to assure that snowmobiles meet minimum safety standards

  D. North America — The geographical area that makes up the United States and Canada

  E. Prototype — The first thing of its kind, or a model that serves as a guide for building other things like it

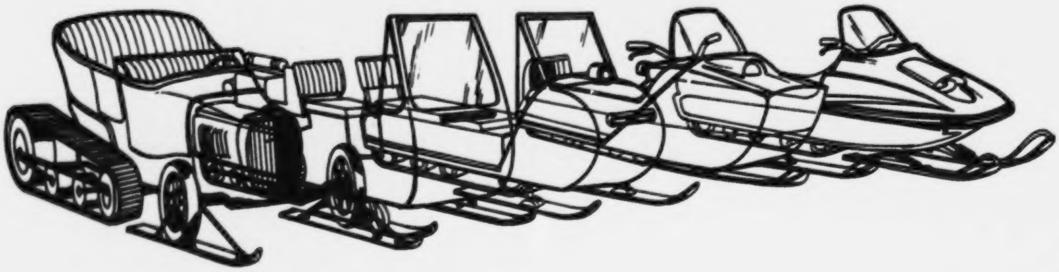
  F. Toboggan — A long flat sled with curved boards at the front; it has no runners and is usually used for coasting down snow-covered inclines

II. **Snowmobile history**

  A. The technology that inspired snowmobiles began in the early 20th century when Americans and Canadians in snowbelt areas adapted automobiles to travel in the snow.

  B. Early snowmobiles had rear-mounted engines and metal tracks which made them heavy, and they were called motorized toboggans or snow machines. (Figure 1)

FIGURE 1



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INFORMATION SHEET

C. Carl J. Eliason built and marketed the first snow machine in Wisconsin in 1917.

D. Eliason's first motorized toboggan went into production in 1922, and 40 such machines were built from 1922 to 1926 with 2.5 horsepower outboard engines.

E. During the 1920's, E.M. Tucker designed and built the first Sno-Cat.

(NOTE: A variation of this machine was used by the British Trans-Atlantic Expedition during 1957 and 1958.)

F. In 1928, the Ford Motor Company built a special snowmobile for Admiral Byrd's polar expedition.

G. In 1926, Joseph Bombardier of Quebec, Canada, built a wind sled that used a Ford engine and a large propeller, and skis were used to steer the machine.

(NOTE: A few years later, Bombardier replaced the propeller with a single track.)

H. In 1932, Eliason produced the first snowmobile powered by a converted motorcycle engine, and it attained speeds of 40 miles per hour.

I. In 1936, Bombardier produced an over-snow vehicle that was steered with skis, looked like an army tank, and could hold 30 people.

J. In the late 30's, Bombardier introduced the first snowmobile that ran on rubber tracks driven by a sprocket, a design that became a standard for the industry.

K. In 1954, Allan Hetteen and David Johnson marketed a two-passenger Sno-Traveler, the first snowmobile in the Polaris line.

L. In 1958, Bombardier built the first modern snowmobile with a lightweight motorcycle engine and the first centrifugal clutch; the entire design became an industry standard and the centrifugal clutch revolutionized snowmobiles.

(NOTE: That prototype machine was called a "Ski Dog," but when the 500-pound machine went into production, the name was changed to "Ski-Doo" and 225 Ski-Doo's were sold in 1959.)

M. By the mid-1960's, forty thousand snowmobiles had been sold in the USA and Canada, and by 1970, half a million snowmobiles had been sold.

N. In 1969, the International Snowmobile Industry Association listed 21 manufacturers of snowmobiles, but by the mid-1970's the number of manufacturers had risen to more than 75.

INFORMATION SHEET

O. The manufacturing glut of the mid-70's oversupplied the market, but eventually, only four major manufacturers survived, and the snowmobile continues to gain in popularity.

(NOTE: Those manufacturers are: ARTCO which produces the Artic Cat, Bombardier which produces Ski-Doo, Polaris which produces Polaris, and Yamaha which produces Yamaha snowmobiles.)

III. **Contemporary snowmobiles**

A. Today there are over 10 million active snowmobilers in the United States and Canada.

B. Snowmobilers spend more than two billion dollars a year.

C. An important element in snowmobile popularity is that 80 percent of snowmobile owners consider the sport a family activity.

D. The snowmobile industry is promoted around the world by the International Snowmobile Industry Association (ISIA).

E. The ISIA has distributed more than one million copies of the *Snowmobiler's Safety Handbook.*

(NOTE: According to the ISIA, more than 800,000 snowmobilers have received formal safety training.)

F. There are 10,000 snowmobile clubs in North America.

G. There are an estimated 190,000 miles of established snowmobile trails in the USA and Canada.

IV. **Snowmobile types and their uses**

A. Sport models — Designed for general recreational use and racing

(NOTE: These snowmobiles have medium-size frames and medium to large engines and account for about 80% of snowmobiles in use.)

B. Utility models — Designed for people in heavy snow areas who use them for a primary means of transportation during the snow months.

(NOTE: These models generally have small or moderate size two-stroke engines, and sacrifice speed for dependability.)

C. Workhorse models — Designed for hauling people and materials, and usually have multiple seating capacities and rugged engine and larger frames to take harder service.

(NOTE: Workhorse models are used by law officers, civil defense people, ski-touring centers, and winter recreation areas where trails have to be cared for.)

INFORMATION SHEET

V. **Modern snowmobile components and their functions** (Transparency 1)

A. Chassis — The frame of the snowmobile which supports all other systems

B. Engine — The source of power generation, frequently a two-stroke motor

C. Drive train — The system that transfers energy from the engine to the track through a variable clutch system

D. Track — The system that contacts the snow or ice surface and propels the snowmobile

E. Front suspension — The shock absorbing system which provides safe, comfortable handling of a snowmobile

F. Skis — The long, slender pieces of metal at the front of the snowmobile which allow it to glide on snow, ice, and frozen terrain

(NOTE: The skis are also part of the front suspension.)

G. Steering — The system which permits a driver to move the snowmobile in a selected direction

VI. **Snowmobile chassis systems**

A. The chassis is the body or frame of a snowmobile and may be made from aluminum to enhance lightweight characteristics or spot-welded iron for durability.

B. The chassis supports the weight of other snowmobile systems and provides space and seating support for an operator.

C. The chassis also includes the hood, skid frame, storage compartments, gas tank, front and rear bumpers, foot rests, and options such as snow flaps and console.

D. The console contains instruments such as the speedometer, tachometer, fuel gauge, and temperature gauge.

E. The console also houses the choke lever and cable, the heating coil for the handlebar warmer, the ignition switch, a fuse box, and may also house the handlebars.

VII. **Snowmobile engine systems**

A. Most snowmobile engines are two-stroke (two-cycle) engines with basic components that include:

1. Piston
2. Crankshaft
3. Connecting rod

INFORMATION SHEET

B. Other systems and components of a snowmobile engine include:

1. The carburetor
2. The cooling system
3. Ignition system and spark plugs
4. Carburetion and fuel system
5. Lubrication system (pre-mix or injection system)
6. An exhaust system

VIII. **Snowmobile drive systems**

A. The drive system transfers energy from the engine to the track through a variable-speed clutch and belt assembly that works like an automatic transmission in a car.

B. The variable-speed clutch is unique to snowmobiles and has greatly enhanced performance by reducing the loss of inertia produced by shifting mechanical gears.

C. The drive clutch is sometimes called the centrifugal clutch, and the driven clutch is sometimes called the torque converter.

D. The drive clutch and the driven clutch are connected by a belt which requires special alignment.

(NOTE: The drive system is an essential element in the process of fine tuning a snowmobile.)

IX. **Snowmobile track systems**

A. The track system propels the snowmobile over ice, snow, or what have you, and must be rugged.

B. Tracks are made of rubber or polyurethane arranged in a wide, flat band with cross bars that dig into the running surface.

C. The track may also be fitted with studs or drive lugs to provide better traction.

D. The rear suspension system with its slide rail or bogie wheels is usually considered a part of the track system.

(NOTE: Bogie wheels appear mostly on older model sleds.)

INFORMATION SHEET

X. **Snowmobile suspension systems**

A. Suspension, skis, and steering make up the front suspension, and all three components work together to provide safe, comfortable handling of a snowmobile.

B. There are three types of suspensions:

1. Independent front suspensions
2. Front strut suspensions
3. Conventional leafspring front suspensions

XI. **General snowmobile operator safety**

A. Operator safety has become the prime concern of all snowmobile manufacturers, and is treated in several different publications.

B. Two outstanding publications from ISIA are the *Snowmobiler's Safety Handbook* and the *Snowmobile Operator's Training Program.*

(NOTE: Your instructor has an address where you can write ISIA if you're interested in either publication for your personal use or as a gift for a snowmobiling friend.)

C. States offer operator training programs, but local snowmobile clubs are the best source for general operator training and safety advice pertinent to local conditions.

D. Two major problem areas confront snowmobilers:

1. Inadequate or dangerous trails
2. Difficult or dangerous riding conditions

E. Injuries to snowmobilers have been caused by:

1. Cables and guy wires
2. Fences
3. Tree stumps, rocks, and other obstacles hidden under snow cover
4. Low hanging tree branches
5. Unsafe ice conditions

INFORMATION SHEET

F. Since the major goal of most snowmobile clubs is to establish and maintain safe, well-marked trails, local clubs contribute significantly to snowmobile safety.

(NOTE: Some clubs do publish important safety material especially for local conditions.)

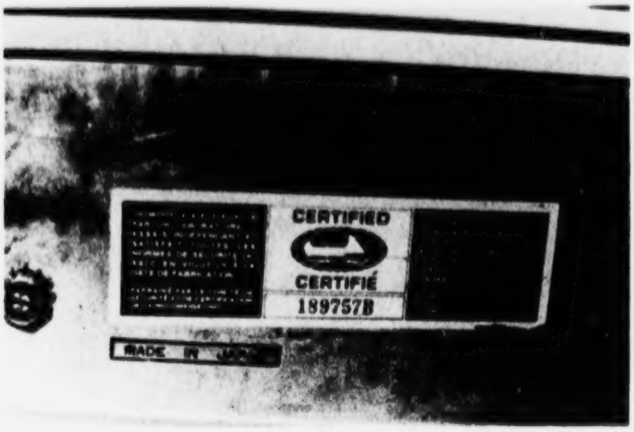
XII. **General snowmobile repair safety**

A. Standards covering safe manufacture of all systems in a snowmobile are established by the Snowmobile Safety and Certification Committee.

B. Most snowmobiles carry an SSCC certification label to indicate the machine is in compliance with safety standards (Figure 2).

(NOTE: The label is usually black and white and located on the right rear tunnel of the snowmobile.)

FIGURE 2

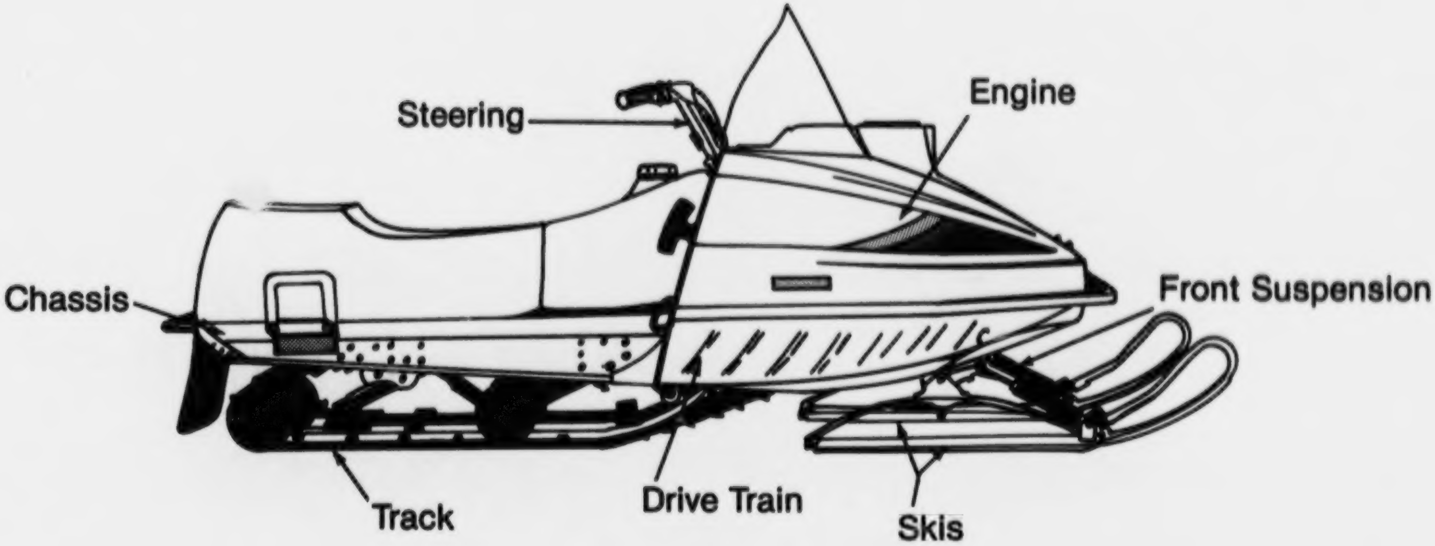


C. It is very important that repair work follows specifications by the manufacturer because variations from those specifications result in placing the machine out of compliance with safety standards.

D. Repairing snowmobiles requires the use of basic hand tools and specialized tools that require safe use and proper maintenance.

E. One of the most important rules for personal safety when repairing a snowmobile is to wear safety glasses at all times.

Parts of a Snowmobile


Steering
Engine
Chassis
Front Suspension
Track
Drive Train
Skis

INTRODUCTION TO SNOWMOBILE REPAIR
UNIT I

ASSIGNMENT SHEET #1 — SOLVE PROBLEMS RELATED TO SNOWMOBILE OPERATOR AND REPAIR SAFETY

Directions: Read the following problems carefully and recommend the best solution.

A. You have been called upon to talk to a group of new owners of snowmobiles about snowmobile safety in general, but what two problem areas should you address first?

____

____

B. A friend repairing a snowmobile says that the specifications in the manufacturer's service manual don't have to be followed closely. What should you say to your friend?

____

____

C. A group of people who want to start a local snowmobile club want advice about their objectives. What would you tell them is the major goal of a local snowmobile club?

____

____

D. Local snowmobilers are planning a trail and have asked you about the types of hazards they should look for. What would you tell them?

____

____

____

E. Someone wants to know if there is any written information about snowmobile safety and operation beyond the materials published by the manufacturer. What would you recommend to that person?

____

____

INTRODUCTION TO SNOWMOBILE REPAIR
UNIT I

ANSWERS TO ASSIGNMENT SHEET #1

A. The problems posed by inadequate or dangerous trails, and the other hazards posed by difficult or dangerous riding conditions

B. Failure to follow the manufacturer's specifications may lead to a violation of safety standards

C. To establish and maintain safe, well-marked trails

D. Watch out for and mark cables and guy wires and fences; mark or remove tree stumps, rocks, or other obstacles that can be hidden by snow; remove low hanging tree branches, and flag or mark unsafe ice conditions

E. The *Snowmobiler's Safety Handbook* and the *Snowmobile Operator's Training Program*, or any materials that may be available about special local safety needs

INTRODUCTION TO SNOWMOBILE REPAIR
UNIT I

NAME ______________________

TEST

1. Match each term on the right with its correct definition.

______a. A group dedicated to promoting the safe manufacture and use of snowmobiles all over the world

______b. A group dedicated to promoting the ownership and enjoyment of snowmobiles for recreational purposes

______c. A group that maintains manufacturing standards to assure that snowmobiles meet minimum safety standards

______d. The geographical area that makes up the United States and Canada

______e. The first thing of its kind, or a model that serves as a guide for building other things like it

______f. A long flat sled with curved boards at the front; it has no runners and is usually used for coasting down snow-covered inclines

1. SSCC
2. Prototype
3. North America
4. ISIA
5. Toboggan
6. ISC

2. Complete statements concerning snowmobile history by circling the word(s) or number(s) that best completes each statement.

a. The technology that inspired snowmobiles began in the early (**19th, 20th**) century when Americans and Canadians in snowbelt areas adapted automobiles to travel in the snow.

b. Early snowmobiles had rear-mounted engines and metal tracks which made them heavy, and they were called motorized (**toboggans, sleds**) or snow machines.

c. Carl J. Eliason built and marketed the first snow machine in (**Minnesota, Wisconsin**) in 1917.

d. Eliason's first motorized toboggan went into production in 1922, and 40 such machines were built from 1922 to 1926 with 2.5 horsepower (**outboard, motorcycle**) engines.

e. During the (**1920's, 1930's**), E.M. Tucker designed and built the first Sno-Cat.

f. In 1928, the (**Ford, Chrysler**) Motor Company built a special snowmobile for Admiral Byrd's polar expedition.

TEST

g. In 1926, Joseph Bombardier of Quebec, Canada, built a wind sled that used a Ford engine and a large propeller, and (**skis, tracks**) were used to steer the machine.

h. In 1932, Eliason produced the first snowmobile powered by a converted (**motorcycle, outboard**) engine, and it attained speeds of 40 miles per hour.

i. In 1936, Bombardier produced an over-snow vehicle that was steered with skis, looked like (**a bus, an army tank**), and could hold 30 people.

j. In the late 30's, Bombardier introduced the first snowmobile that ran on rubber tracks, driven by a (**worm gear, sprocket**), a design that became a standard for the industry.

k. In 1954, Allan Hetteen and David Johnson marketed a two-passenger Sno-Traveler, the first snowmobile in the (**Polaris, John Deere**) line.

l. In 1958, Bombardier built the first modern snowmobile with a lightweight motorcycle engine and the first centrifugal clutch; the entire design became an industry standard and the (**motorcycle engine, centrifugal clutch**) revolutionized snowmobiles.

m. By the mid-1960's, forty thousand snowmobiles had been sold in the USA and Canada, and by 1970, (**half a million, two million**) snowmobiles had been sold.

n. In 1969, the International Snowmobile Industry Association listed 21 manufacturers of snowmobiles, but by the mid-1970's the number of manufacturers had risen to more than (**50, 75**).

o. The manufacturing glut of the mid-70's oversupplied the market, but eventually, only (**four, six**) major manufacturers survived, and the snowmobile continues to gain in popularity.

3. Select true statements concerning contemporary snowmobiles by placing an "X" beside each statement that is true.

_____a. Today there are over 50 million active snowmobilers in the United States and Canada.

_____b. Snowmobilers spend more than two billion dollars a year.

_____c. An important element in snowmobile popularity is that 80 percent of snowmobile owners consider the sport a family activity.

_____d. The snowmobile industry is promoted around the world by the International Snowmobile Industry Association.

_____e. The ISIA has distributed more than one million copies of the *Snowmobiler's Safety Handbook.*

_____f. There are 5,000 snowmobile clubs in North America.

_____g. There are an estimated 190,000 miles of established snowmobile trails in the USA and Canada.

TEST

4. Match snowmobile types with their uses.

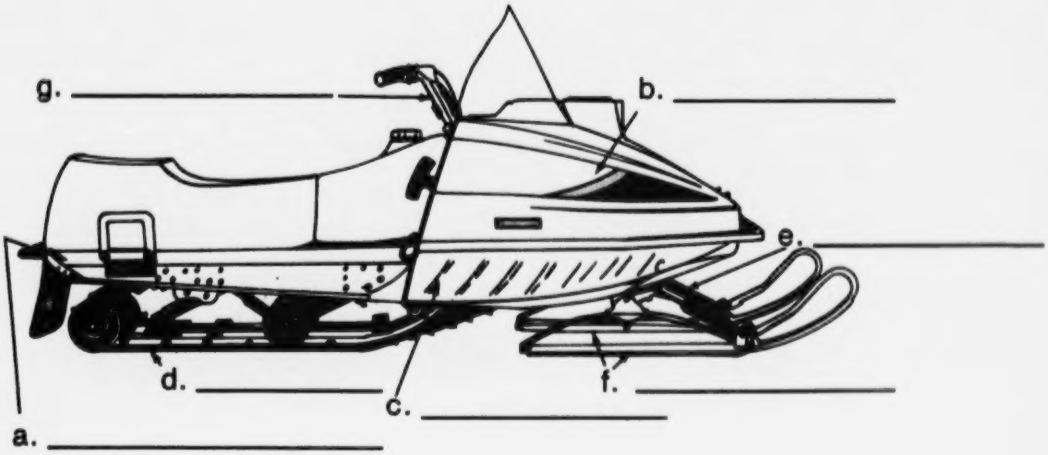
_____a. Designed for general recreational use and racing

_____b. Designed for people in heavy snow areas who use them for a primary means of transportation during the snow months.

_____c. Designed for hauling people and materials, and usually have multiple seating capacities and rugged engine and larger frames to take harder service.

1. Utility models
2. Workhorse models
3. Sport models

5. Identify snowmobile components by placing the correct component name in the blank provided.



TEST

6. Select true statements concerning snowmobile chassis systems by placing an "X" beside each statement that is true.

_____a. The chassis is the body or frame of a snowmobile and may be made from aluminum to enhance lightweight characteristics or spot-welded iron for durability.

_____b. The chassis supports the weight of other snowmobile systems and provides space and seating support for an operator.

_____c. The chassis also includes the hood, skid frame, storage compartments, gas tank, front and rear bumpers, foot rests, and options such as a roll bar and snow flaps, and console.

_____d. The console contains instruments such as the speedometer, tachometer, fuel gauge, and variable clutch.

_____e. The console also houses the choke lever and cable, the heating coil for the handlebar warmer, the ignition switch, a fuse box, and may also house the handlebars.

7. Complete statements concerning snowmobile engine systems by inserting the word(s) that best completes each statement.

a. Most snowmobile engines are two-stroke engines with basic components that include:

1) _____________

2) Crankshaft

3) Connecting _____________

b. Other systems and components of a snowmobile engine include:

1. The _____________________

2. The cooling system

3. _________________ systems and spark plugs

4. Carburetion and _________________ system

5. _________________ system (pre-mix or injection system)

6. An _______________ system

TEST

8. Complete statements concerning snowmobile drive systems by inserting the word(s) that best completes each statement.

   a. The drive system transfers energy from the engine to the ____________ through a variable-speed clutch and belt assembly that works like an automtic transmission in a car.

   b. The variable-speed clutch is unique to snowmobiles and has greatly enhanced performance by ____________ the loss of inertia produced by shifting mechanical gears.

   c. The drive clutch is sometimes called the ____________ clutch, and the driven clutch is sometimes called the torque converter.

   d. The drive clutch and the driven clutch are connected by a belt which requires special ____________.

9. Select true statements concerning snowmobile track systems by placing an "X" beside each statement that is true.

   _____a. The track system propels the snowmobile over ice, snow, or what have you, and must be rugged.

   _____b. Tracks are made of rubber or polyurethane arranged in a wide, flat band with cross bars that dig into the running surface.

   _____c. The track may also be fitted with studs or drive lugs to provide better traction.

   _____d. The rear suspension system with its slide rail or bogie wheels is not usually considered a part of the track system.

10. Complete statements concerning snowmobile suspension systems by inserting the word(s) that best completes each statement.

    a. Suspension, skis, and ____________ make up the front suspension, and all three components work together to provide safe, comfortable handling of a snowmobile.

    b. There are three types of suspensions:

       1) ____________ front suspensions

       2) ____________ strut suspensions

       3) Conventional ____________ front suspensions

TEST

11. Complete statements concerning general snowmobile operator safety by inserting the word(s) that best completes each statement.

    a. Operator ____________ has become the prime concern of all snowmobile manufacturers, and is treated in several different publications.

    b. Two outstanding publications from ISIA are the *Snowmobiler's* ____________ *Handbook* and the *Snowmobile* ____________ *Training Program.*

    c. States offer operator training programs, but local snowmobile ____________ are the best source for general operator training and safety advice pertinent to local conditions.

    d. Two major problem areas confront snowmobilers:

        1) Inadequate or ____________ trails

        2) Difficult or ____________ riding conditions

    e. Injuries to snowmobilers have been caused by:

        1) Cables and ____________ wires

        2) Fences

        3) Tree stumps, rocks, and other ____________ hidden under snow cover

        4) Low hanging ____________ ____________

        5) Unsafe ____________ conditions

    f. Since the major goal of most snowmobile clubs is to establish and maintain safe, well-marked ____________, local clubs contribute significantly to snowmobile safety.

12. Select true statements concerning general snowmobile repair safety by placing an "X" beside each statement that is true.

    _____a. Standards covering safe manufacture of all systems in a snowmobile are established by the Snowmobile Safety and Certification Committee.

    _____b. Most snowmobiles do not carry an SSCC certification label to indicate the machine is in compliance with safety standards.

    _____c. It is very important that repair work follows specifications by the manufacturer because variations from those specifications result in placing the machine out of compliance with safety standards.

    _____d. Repairing snowmobiles requires the use of basic hand tools and specialized tools that require safe use and proper maintenance.

    _____e. One of the most important rules for personal safety when repairing a snowmobile is to wear sun glasses at all times.

TEST

(NOTE: If the following activity has not been accomplished prior to the test, ask your instructor when it should be completed.)

13. Solve problems related to snowmobile operator and repair safety. (Assignment Sheet #1)

INTRODUCTION TO SNOWMOBILE REPAIR
UNIT I

ANSWERS TO TEST

1. a. 4
   b. 6
   c. 1
   d. 3
   e. 2
   f. 5

2. a. 20th
   b. Toboggans
   c. Wisconsin
   d. Outboard
   e. 1920's
   f. Ford
   g. Skis
   h. Motorcycle
   i. An army tank
   j. Sprocket
   k. Polaris
   l. Centrifugal clutch
   m. Half a million
   n. 75
   o. Four

3. b, c, d, e, g

4. a. 3
   b. 1
   c. 2

5. a. Chassis
   b. Engine
   c. Drive train
   d. Track
   e. Front suspension
   f. Skis
   g. Steering

6. a, b, c, e

7. a. 1) Piston
      3) Rod
   b. 1) Carburetor
      3) Ignition
      4) Fuel
      5) Lubrication
      6) Exhaust

ANSWERS TO TEST

8. a. Track
    b. Reducing
    c. Centrifugal
    d. Alignment

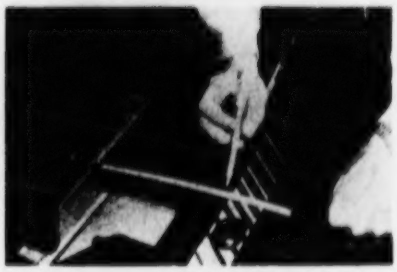
9. a, b, c

10. a. Steering
    b. 1) Independent
        2) Front
        3) Leafspring

11. a. Safety
    b. Safety, operator's
    c. Clubs
    d. 1) Dangerous
        2) Dangerous
    e. 1) Guy
        3) Obstacles
        4) Tree branches
        5) Ice
    f. Trails

12. a, c, d

13. Evaluated to the satisfaction of the instructor



STEERING, FRONT SUSPENSION, AND SKIS

UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to discuss functions of the steering mechanism. The student should also be able to discuss what to look for when inspecting skis and differences and similarities of three front suspension systems. These competencies will be evidenced by correctly performing the procedures outlined in the assignment and job sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to steering, front suspension, and skis with their correct definitions.
2. Complete statements concerning steering mechanisms.
3. Select true statements concerning ski alignment.
4. Complete statements concerning front suspensions.
5. Complete statements concerning leafspring front suspension.
6. Select true statements concerning independent front suspension.
7. Complete statements concerning strut suspension.
8. Complete statements concerning comparisons of front suspension systems.
9. Select true statements concerning skis.
10. Select true statements concerning ski inspection.
11. Solve problems related to skis and steering. (Assignment Sheet #1)
12. Demonstrate the ability to:
    a. Remove, inspect, and replace tie rods. (Job Sheet #1)
    b. Remove and replace ski skegs. (Job Sheet #2)
    c. Adjust ski alignment on a snowmobile. (Job Sheet #3)

STEERING, FRONT SUSPENSION, AND SKIS
UNIT II

SUGGESTED ACTIVITIES

A. Provide students with objective sheet.

B. Provide students with information sheet.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Demonstrate and discuss procedures outlined in the job sheets.

G. Visit a dealership and have students write a written report for class.

H. Disassemble, clean, inspect, and reassemble a steering system.

I. Have students discuss the three types of front suspensions.

J. Check a sled for steering play.

K. Give test.

CONTENTS OF THIS UNIT

A. Objective sheet

B. Information sheet

C. Transparency masters

  1. TM 1 — Independent Front Suspension

  2. TM 2 — Yamaha Telescopic Strut Suspension

D. Assignment Sheet #1 — Solve Problems Related to Skis and Steering

E. Answers to assignment sheet

F. Job sheets

  1. Job Sheet #1 — Remove, Inspect, and Replace Tie Rods

  2. Job Sheet #2 — Remove and Replace Ski Skegs

  3. Job Sheet #3 — Adjust Ski Alignment on a Snowmobile

G. Test

H. Answers to test

REFERENCES USED IN DEVELOPING THIS UNIT

A. *Snowmobile Repair.* Stillwater, OK 74074: Mid-America Vocational Curriculum Consortium, 1976.

B. *Chilton's Snowmobiles Repair & Tune-Up Guide,* Second edition. Radnor, PA: Chilton Book Co., 1975.

C. *Arctic Cat Service Manual No. 2254-302.* Thief River Falls, MN 56701: ARCTCO, Inc., 1984.

D. *1980 Bombardier Snowmobiles Shop Manual.* Valcourt, Quebec, Canada: Bombardier, Ltd., 1980.

E. *Kawasaki Drifter Snowmobile Shop Manual.* Santa Ana, CA 92799-5252: Kawasaki Motors Corp., U.S.A., 1980.

F. *Kawasaki Parts Catalog SB340-A2, SB440-A5.* Santa Ana, CA 92799-5252: Kawasaki Motors Corp., U.S.A., 1980.

STEERING, FRONT SUSPENSION, AND SKIS
UNIT II

INFORMATION SHEET

I. **Terms and definitions**

A. Handlebars — The steering control apparatus which is rotated right or left to turn the skis in the direction of intended travel

B. Grip — A cylindrical piece of rubber which is glued to the handlebars to give hand comfort to the operator and to aid the hands from slipping off the handlebars

C. Steering post — A long cylindrical piece of metal which extends from the handlebars through the chassis to the tie rods

D. Tie rods — Rods which link the steering column to the steering arm.

E. Spindle arm — The ski leg which is connected to the tie rods and connects the skis to the steering assembly.

F. Toe out — A ski position where the front of each ski points outward

G. Toe in — A ski position where the front of each ski points inward

H. Play — The nature of a mechanism to be free to move or to move too much after wear

I. Skis — Long, slender pieces of metal which extend outward from under a snowmobile to its front which allow the vehicle to glide over snow and to be steered

J. Skeg — A ski wear rod or runner used to reduce wear on the ski and to improve directional control

K. Shock absorber — A round cylinder filled with gas or lubricant and connected to the skis and spindle arm to absorb the impact of bumpy surfaces on the snowmobile chassis

L. Flotation — The relationship between snowmobile weight and the amount of surface area of the skis and track supporting it on the snow

M. Saddle — A mounting bracket which accepts the main leafspring allowing it to ride and connect with the ski

INFORMATION SHEET

II. **Steering mechanisms**

A. The steering assembly controls the direction of travel of the snowmobile.

B. The handlebars serve as the assembly control which, when rotated left or right, turn the skis in the direction of travel.

C. Attached to the handlebars is a lever-type throttle control, an emergency stop switch and the headlight hi-lo beam switch.

D. The skis are turned in the direction of intended travel from the handlebars, through a system of tie rods and linkages to the skis.

E. The tie rods transfer movement to the spindle which, in turn, causes movement to the left or right of the entire ski.

F. The steering system should be checked periodically to be sure its movement is not restricted, and also to be sure there is not excessive play.

G. The steering post should be examined occasionally for cracks or bends which could adversely affect steering.

H. Tie rods, tie rod ends, and bushings should be checked regularly for wear, breakage, or signs of excessive stress.

III. **Ski alignment**

A. The proper positioning of the skis is essential to the function of the steering system.

B. Most manufacturers require that skis be aligned parallel to each other.

C. Bombardier recommends that their Ski-Doo snowmobiles be aligned slightly toe out.

Example: Bombardier recommends measuring the distance between each ski at the front and the rear of the springleaves. The front distance should be 3 mm, or 1/8 inch, more than the rear when the skis are pointed straight ahead.

D. Align skis by adjusting the tie rod ends while the front skis are pointed straight ahead and the handlebars are in the normal, straight ahead driving position.

E. Make sure the skis do not bind on any surface obstruction to assure a proper adjustment, and always follow manufacturer's recommendations for adjustment measurement and torque specifications.

INFORMATION SHEET

IV. **Front suspensions**

A. The major purpose of the front suspension on a snowmobile is to support the steering system.

B. The suspension system cushions the front of the sled from bumps to help improve control of the vehicle and cushion the ride.

C. Modern snowmobiles use three types of front suspensions:

1. Conventional leafspring suspension
2. Independent front suspension
3. Strut suspension

V. **Leafspring front suspension**

A. Leafsprings are pieces of flat steel which extend down from the spindle to brace the skis.

B. A shock absorber may be attached to a set of leafsprings.

C. Some snowmobiles have several leafsprings.

D. To check the tension on a shock absorber:

1. Hold the body of the shock firmly.
2. Quickly compress and extend the plunger.
3. Resistance should be felt in both directions.
4. If the shock is leaking lubricant, it should be replaced.

VI. **Independent front suspension** (Transparency 1)

A. Many later model snowmobiles have independent front suspension as standard equipment.

B. Independent suspension systems are not tied directly to the steering post assembly; each ski is allowed to take shocks separately.

C. Each ski has its own shock absorbing mechanism which is either a shock absorber inside a spring, or separate spindle arms each supported by a strut.

D. Some snowmobiles have an A-frame independent suspension similar in design to many modern automobile suspensions.

INFORMATION SHEET

VII. **Strut suspension** (Transparency 2)

A. A strut suspension is similar to conventional leafspring suspensions except that instead of a shock absorber, a longer strut mechanism is used to cushion and support the snowmobile.

B. A strut suspension is found almost exclusively on Yamaha snowmobiles.

(NOTE: The Yamaha design is called the Telescopic Strut Suspension or TSS.)

C. The strut suspension on snowmobiles is similar to the strut suspension found in the nose gear of aircraft.

D. A strut is attached to each ski, encases oil and a spring, or some are filled with nitrogen.

E. The strut is considered a stronger shock absorbing mechanism than the conventional shock absorber.

F. The strut extends a longer distance between the ski and spindle arm which serves to absorb more impact before reaching the snowmobile chassis.

VIII. **Comparisons of front suspension systems**

A. The conventional leafspring suspension systems are reliable and less expensive to maintain than independent or strut suspensions.

B. Independent suspension systems are reliable and greatly enhance the smoothness of the ride by absorbing the shock to the individual skis rather than to the entire chassis.

C. Strut suspensions are reliable, stronger than leafspring/absorber suspensions, and absorb shocks more efficiently.

IX. **Skis**

A. A snowmobile travels on snow because of ski flotation.

B. The skis provide support for the snowmobile and comfort the ride.

C. The skis grip the snow surface so that the vehicle can be steered.

D. A ski wear rod is located underneath the ski and serves to reduce ski wear and to greatly improve directional control.

E. The ski wear rod is also called a "skeg" or "runner shoe."

INFORMATION SHEET

F. Skis and ski skegs should be inspected frequently for excessive wear, and skegs should be replaced in pairs.

G. A rubber rebound bumper connected to the underside of the main springleaf serves to prevent chafing of the skis by the leafspring.

H. The rebound bumper should be inspected for signs of wear, an indication that the shock absorbers may need to be replaced or that there are other suspension problems.

X. Ski inspection

A. Always inspect welded areas for cracks or deterioration.

B. Inspect bolts for stripped or damaged threads.

C. Inspect the holes where the springs are mounted to the skis for damage or elongation.

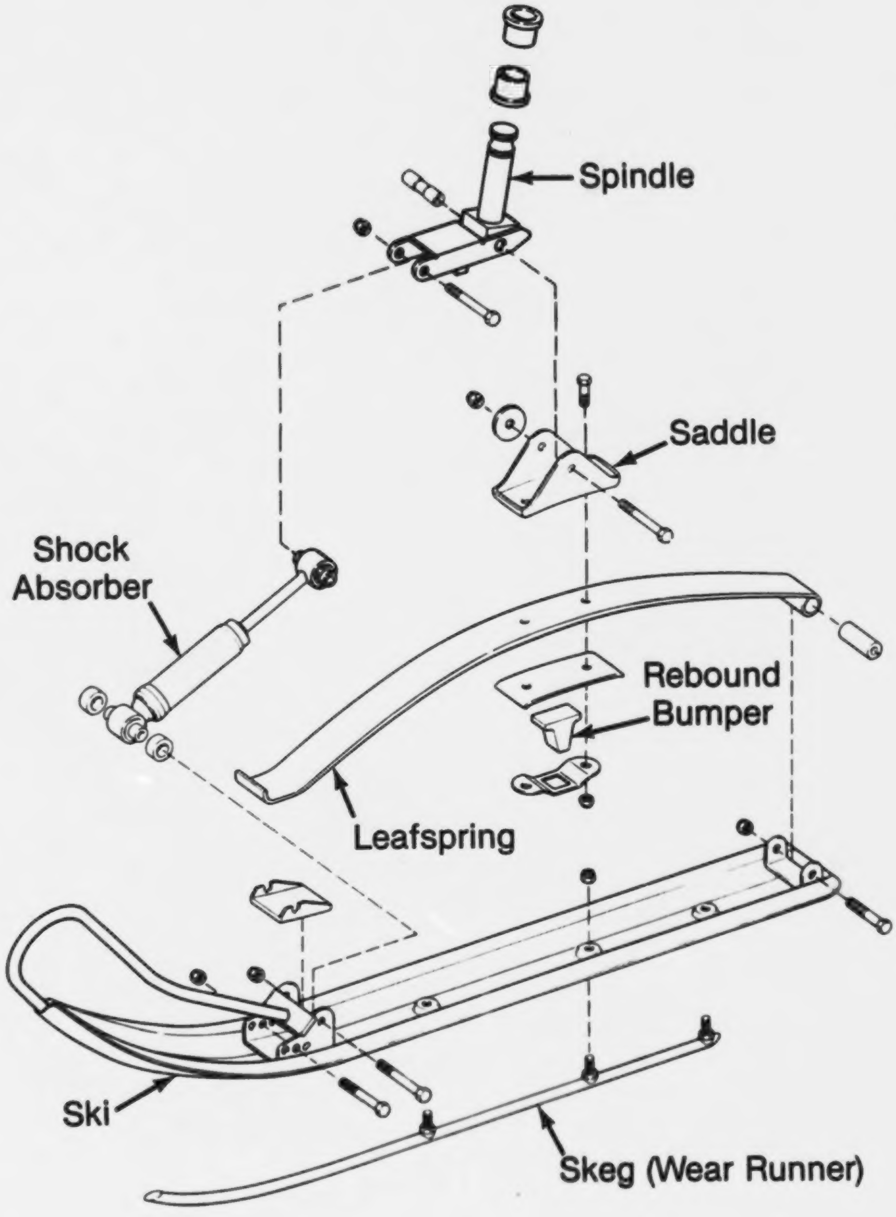
D. Inspect the ski for abnormal bends or cracks.

E. Inspect ski springleaves for wear or cracks.

F. Inspect the shock-absorber body and plunger for nicks, cracks, and bends.

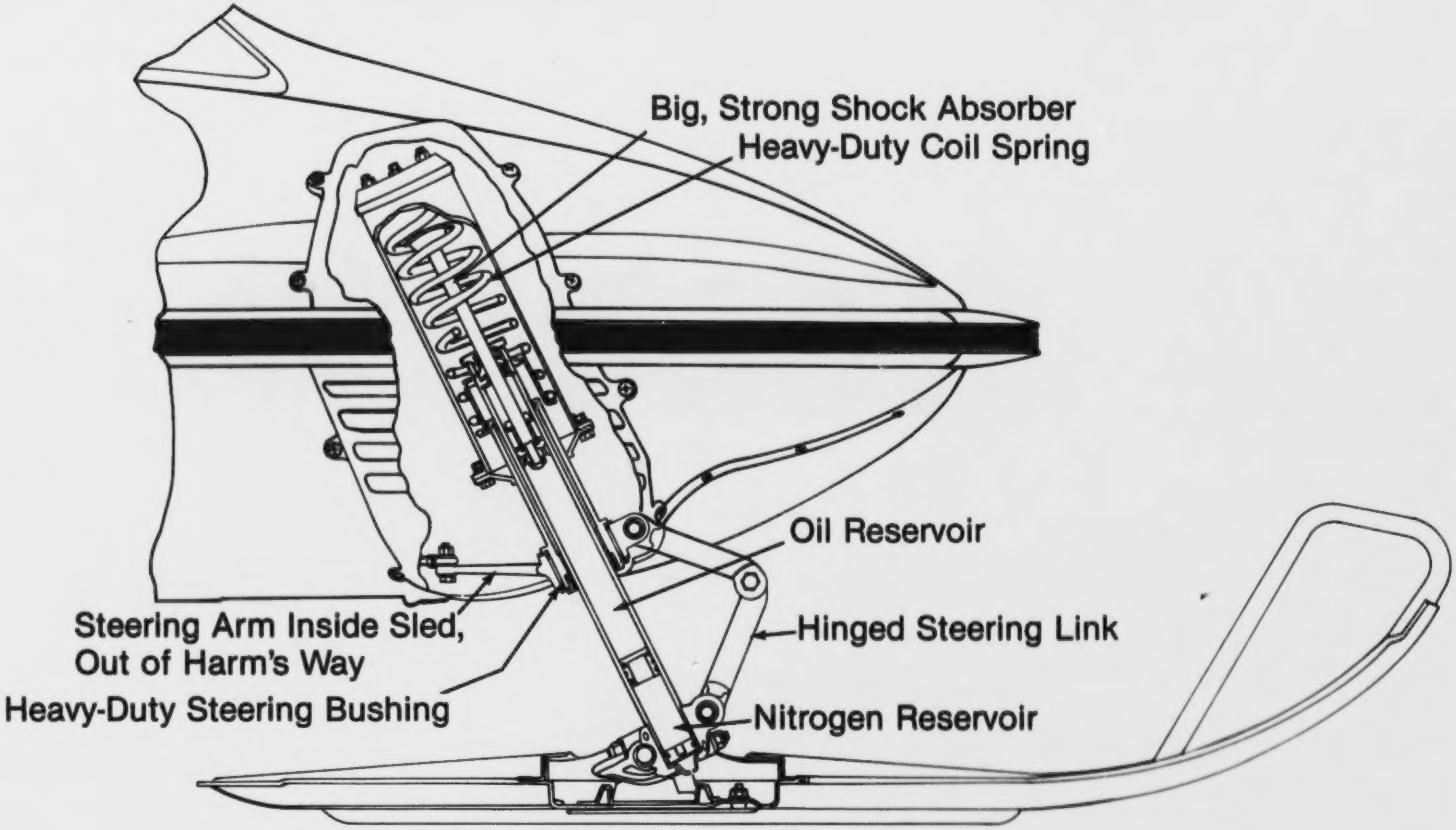
G. Check ski alignment at the beginning of each season.

Independent Front Suspension


Spindle
Saddle
Shock
Absorber
Rebound
Bumper
Leafspring
Ski
Skeg (Wear Runner)

Courtesy Kawasaki Motors Corp., U.S.A.

Yamaha Telescopic Strut Suspension


Big, Strong Shock Absorber
Heavy-Duty Coil Spring
Oil Reservoir
Hinged Steering Link
Nitrogen Reservoir
Steering Arm Inside Sled, Out of Harm's Way
Heavy-Duty Steering Bushing

Courtesy Yamaha Motor Corporation, U.S.A.

STEERING, FRONT SUSPENSION, AND SKIS
UNIT II

ASSIGNMENT SHEET #1 — SOLVE PROBLEMS RELATED TO SKIS AND STEERING

Directions: Read the following problems carefully and recommend the best solution.

A. Where would you find reliable guidelines for steering adjustment and maintenance?

B. A friend is thinking about buying a snowmobile for the first time and he asks your opinion about types of front suspension systems. How would you respond?

C. You are assembling the front suspension and skis on a new snowmobile. How do you align the skis?

D. You are about to purchase a three-year-old snowmobile from someone. During your inspection of the steering, front suspension, and skis, what trouble signs should you look for?

STEERING, FRONT SUSPENSION, AND SKIS
UNIT II

ANSWERS TO ASSIGNMENT SHEET #1

A. The specific manufacturer's service manual

B. Describe to him the kind of ride, reliability factors and cost associated with each of the three types of suspensions.

C. Consult the specific manufacturer's manual for specifications for proper alignment, and understand the concept of toe in and toe out.

D. Examine steering post, tie rod and tie ride ends for signs of breakage, excess stress or bends; examine skis and ski runner for bends and excess wear; examine shock absorbers for leakage and for proper tension.

STEERING, FRONT SUSPENSION, AND SKIS
UNIT II

JOB SHEET #1 — REMOVE, INSPECT, AND REPLACE TIE RODS

A. Tools and equipment

1. Snowmobile ski as selected by instructor
2. Appropriate service manual
3. Basic hand tools
4. Replacement parts as required
5. Safety glasses
6. Torque wrench

B. Procedure

1. Put on safety glasses.
2. Remove the engine, if required, for access to the tie rods.
3. Remove tie rod assemblies on both skis. (Figure 1)

FIGURE 1

4. Loosen the jam nuts which secure the tie rod adjusting bolts.

(Note: Apply a thread sealing adhesive,LOCTITE™ or similar to tie rod threaded components upon reassembly)

JOB SHEET #1

5. Remove the tie rod ends from the adjusting bolts.

6. Remove the adjusting bolts with their jam nuts.

7. Remove the jam nuts from the adjusting bolts.

8. Inspect the tie rods for damaged threads.

9. Inspect the tie rods for cracks or bushing wear.

10. Replace worn components as required.

11. Replace the tie rods by reversing the disassembly procedure.

☐ Have your instructor check your work.

12. Complete a ski alignment as outlined in Job Sheet #3 of this unit, and always complete a ski alignment after adjusting tie rods.

13. Clean up area and return tools and materials to proper storage.

STEERING, FRONT SUSPENSION, AND SKIS
UNIT II

JOB SHEET #2 — REMOVE AND REPLACE SKI SKEGS

A. Tools and equipment

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Hand tools
4. Replacement skegs as required
5. Torque wrench
6. Safety glasses

B. Routine #1 — Removing old skegs

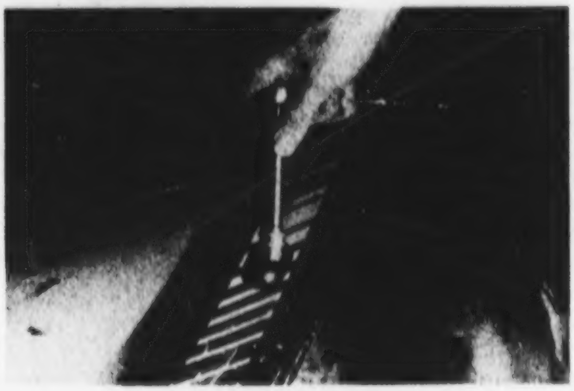
1. Put on safety glasses.
2. Block the machine up or tip it onto its side to provide easy access to the ski or skis, and if you tip the machine over, make sure no gas leaks from the gas tank.
3. Inspect the skegs, and if they are half worn or more than half worn, they should be replaced (Figure 1)

FIGURE 1

JOB SHEET #2

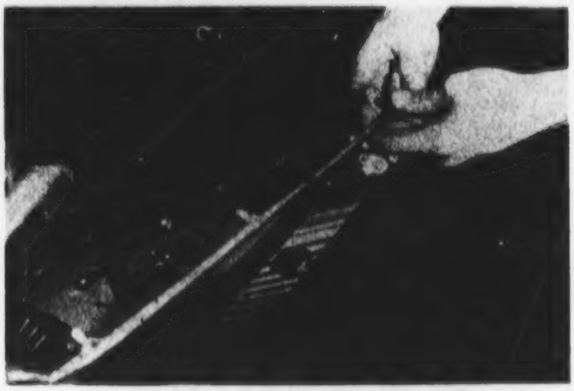
4. Remove the nuts that secure the skeg to the ski (Figure 2)

FIGURE 2



5. Remove the skeg from the ski by pulling the rear of the skeg out first, and then remove the front of the skeg from the ski (Figure 3)

FIGURE 3



6. Repeat the procedure for the other skeg because skegs should always be replaced as a pair.

JOB SHEET #2

C. Routine #2 — Installing new skegs

1. Insert the front of one skeg into the hole at the front of one of the skis
2. Align the studs on the skeg with the mounting holes on the ski and push the studs into place in the ski
3. Install nuts on skeg studs and torque to manufacturer's specifications
4. Repeat the procedure for the other ski and skeg

☐ Have your instructor check your work

5. Follow skeg replacement with ski alignment, and always align skis after skeg replacement.
6. Clean up area and return tools and materials to proper storage.

STEERING, FRONT SUSPENSION, AND SKIS
UNIT II

JOB SHEET #3 — ADJUST SKI ALIGNMENT ON A SNOWMOBILE

A. Tools and materials

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Basic hand tools
4. Measuring tape
5. Straight edge or long straight board
6. Torque wrench
7. Safety glasses

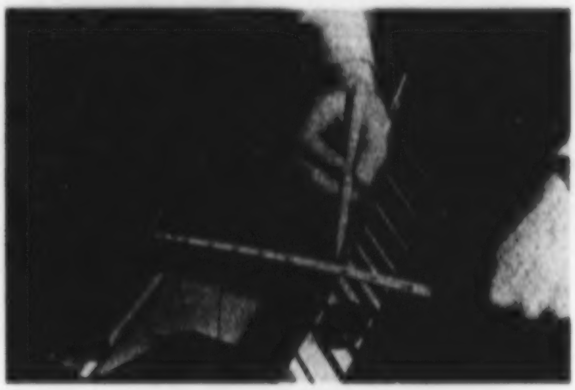
B. Procedure

1. Put on safety glasses
2. Place the snowmobile on a level hard surface, and make sure the skis are not bound
3. Inspect the skis and steering linkage for wear and excessive play
4. Replace any damaged or worn components before completing ski alignment
5. Turn the handlebar to the straight ahead position, and if the handlebar requires centering, adjust tie rod ends as required
6. Place a straight edge or board along the outside edge of the track so that it extends along the inside of one ski

JOB SHEET #3

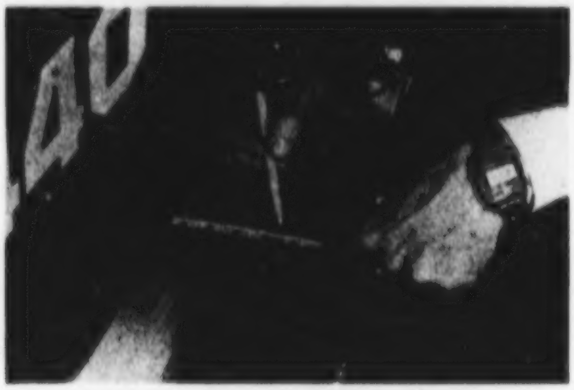
7. Measure the distance from the straight edge to the front of the ski at a measuring point that is common to all points along the ski (Figure 1)

FIGURE 1



8. Measure the distance from the straight edge to the back of the ski at a common measuring point (Figure 2)

FIGURE 2



a. If the front and back measurements of the ski are the same, the first ski is parallel with the track

b. If the front and back measurements are not the same, the ski will require alignment

JOB SHEET #3

9. Remove linkage steering play by moving both ski tips toward the center of the snowmobile

10. Leave the straight edge in place

11. Measure across from the front of the first ski to a measuring point that is common to all points along the other ski (Figure 3)

FIGURE 3

12. Measure across from the back of the first ski to a common measuring point along the back of the other ski (Figure 4)

FIGURE 4

JOB SHEET #3

13. Loosen tie rod jam nuts and turn tie rods as required to complete ski alignment

14. Retighten tie rod jam nuts to manufacturer's torque specifications

    (CAUTION: Make sure that the tie rod end is threaded into the tie rod with enough thread length to prevent steering linkage failure, and check manufacturer's specifications if you have any doubts at all.)

☐ Have your instructor check your work

15. Discuss with your instructor the adjustments required to complete the toe-out alignment required on a Ski-Doo

16. Clean up area and return tools and materials to proper storage

(Note: Apply a thread sealing adhesive,LOCTITE™ or similar to tie rod threaded components upon reassembly)

STEERING, FRONT SUSPENSION, AND SKIS
UNIT II

NAME ____________________

TEST

1. Match each term on the right with its correct definition.

_____a. The steering control apparatus which is rotated right or left to turn the skis in the direction of intended travel

_____b. A cylindrical piece of rubber which is glued to the handlebars to give hand comfort to the operator and to aid the hands from slipping off the handlebars

_____c. A long cylindrical piece of metal which extends from the handlebars through the chassis to the tie rods

_____d. Rods which link the steering column to the steering arm

_____e. The ski leg which is connected to the tie rods and connects the skis to the steering assembly

_____f. A ski position where the front of each ski points outward

_____g. A ski position where the front of each ski points inward

_____h. The nature of a mechanism to be free to move or to move too much after wear

_____i. Long, slender pieces of metal which extend outward from under a snowmobile to its front which allow the vehicle to glide over snow and to be steered

_____j. A ski wear rod or runner used to reduce wear on the ski and to improve directional control

_____k. A round cylinder filled with gas or lubricant and connected to the skis and spindle arm to absorb the impact of bumpy surfaces on the snowmobile chassis

1. Play
2. Toe in
3. Handlebars
4. Flotation
5. Spindle arm
6. Shock absorber
7. Tie rods
8. Toe out
9. Skeg
10. Steering post
11. Saddle
12. Grip
13. Skis

TEST

_____l. The relationship between the snowmobile weight and the amount of surface area of the skis and track supporting it on the snow

_____m. A mounting bracket which accepts the main leafspring allowing it to ride and connect with the ski

2. Complete statements concerning steering mechanisms by circling the word(s) that best completes each statement.

   a. The steering assembly (**impedes, controls**) the direction of travel of the snowmobile.

   b. The (**throttle, handlebars**) serve as the assembly control which, when rotated left or right, turn the skis in the direction of travel.

   c. Attached to the (**steering wheel, handlebars**) is a lever-type throttle control, an emergency stop switch and the headlight hi-lo beam switch.

   d. The (**skis, track**) are turned in the direction of intended travel from the handlebars, through a system of tie rods and linkages to the skis.

   e. The tie rods transfer (**movement, shocks**) to the spindle which, in turn, causes movement to the left or right of the entire ski.

   f. The steering system should be checked periodically to be sure its movement is (**restricted, not restricted**) and also to be sure there is not excessive play.

   g. The steering post should be examined occasionally for cracks or bends which could (**adversely, positively**) affect steering.

   h. Tie rods, tie rod ends and bushings should be (**ignored, checked**) regularly for wear, breakage or signs of excessive stress.

3. Select true statements concerning ski alignment by placing an "X" beside each statement that is true.

   _____a. The proper positioning of the skis is essential to the function of the steering system.

   _____b. Most manufacturers require that skis be aligned toe in to each other.

   _____c. Bombardier recommends that their Ski-Doo snowmobiles be aligned slightly toe out.

   _____d. Alignment is accomplished by adjusting the tie end rod bearings, or jam nuts, as the handlebars are in a vertical position and the snowmobile is lifted off the ground.

   _____e. In ski adjustment, measurement and torque specifications can usually be guessed close enough to be right.

TEST

4. Complete statements concerning front suspensions by inserting the word(s) that best completes each statement.

   a. The major purpose of the front suspension on a snowmobile is to support the ____________ system.

   b. The suspension system cushions the front of the sled from bumps to help improve control of the vehicle and ____________ the ride.

   c. Modern snowmobiles use three types of front suspensions:

      1) Conventional ____________ suspension

      2) ____________ front suspension

      3) ____________ suspension

5. Complete statements concerning leafspring front suspension by inserting the word(s) that best completes each statement.

   a. Leafsprings are pieces of flat ____________ which extend down from the spindle to brace the skis.

   b. A ____________ ____________ may be attached to a set of leafsprings.

   c. Some snowmobiles have several ____________.

   d. To check the tension on a shock absorber:

      1) Hold the ____________ of the shock firmly

      2) Quickly compress and extend the ____________.

      3) ____________ should be felt in both directions.

      4) If the shock is leaking ____________, it should be replaced.

6. Select true statements concerning independent front suspension by placing an "X" beside each statement that is true.

   _____a. Since 1965, most snowmobiles have independent front suspension as standard equipment.

   _____b. Independent suspension systems are not tied directly to the steering post assembly; each ski is allowed to take shocks separately.

   _____c. Each ski has its own shock absorbing mechanism which is either a shock absorber inside a spring, or separate spindle arms each supported by a strut.

   _____d. Some snowmobiles have a T-frame independent suspension similar in design to many modern automobile suspensions.

TEST

7. Complete statements concerning strut suspension by inserting the word(s) that best completes each statement.

   a. A strut suspension is similar to conventional ____________ suspensions except that instead of a shock absorber, a longer strut mechanism is used to cushion and support the snowmobile.

   b. A strut suspension is found almost exclusively on ____________ snowmobiles.

   c. The strut suspension on snowmobiles is similar to the strut suspension found in the nose gear of ____________.

   d. A strut is attached to each ski, encases oil and a spring, or some are filled with ____________.

   e. The strut is considered a stronger shock absorbing mechanism than the conventional ____________.

   f. The strut extends a ____________ distance between the ski and spindle arm which serves to absorb more impact before reaching the snowmobile chassis.

8. Complete statements concerning comparisons of front suspension systems by inserting the word(s) that best completes each statement.

   a. The conventional ____________ suspension systems are reliable and less expensive to maintain than independent or strut suspensions.

   b. ____________ suspension systems are reliable and greatly enhance the smoothness of the ride by absorbing the shock to the individual skis rather than to the entire chassis.

   c. ____________ suspensions are reliable, stronger than leafspring/absorber suspensions, and absorb shocks more efficiently.

9. Select true statements concerning skis by placing an "X" beside each statement that is true.

   _____a. A snowmobile travels on snow because of ski flotation.

   _____b. The skis provide support for the snowmobile and comfort the ride.

   _____c. The skis grip the snow surface so that the vehicle can be steered.

   _____d. The ski wear rod is located above the ski and serves to reduce ski wear and to greatly improve directional control.

   _____e. The ski wear rod is also called a "skeg" or "runner shoe."

   _____f. Skis and skegs should never be inspected frequently for excessive wear.

TEST

_____g. A rubber rebound bumper connected to the underside of the main springleaf serves to prevent chafing of the skis by the leafspring.

_____h. The rebound bumper should be inspected for signs of wear, an indication that the track may need to be replaced, or that there are other suspension problems.

10. Select true statements concerning ski inspection by placing an "X" beside each statement that is true.

_____a. Never inspect welded areas for cracks of deterioration.

_____b. Inspect bolts for stripped or damaged threads.

_____c. Inspect the holes where the springs are mounted to the skis for damage or elongation.

_____d. Inspect the ski for abnormal bends or cracks.

_____e. Never inspect ski springleaves for bends or cracks.

_____f. Inspect the shock-absorber body and plunger for nicks, cracks, and bends.

_____g. Check ski alignment at the beginning of each season.

(NOTE: If the following activities have not been completed prior to the test, ask your instructor when they should be completed.)

11. Solve problems related to skis and steering. (Assignment Sheet #1)

12. Demonstrate the ability to:

    a. Remove, inspect, and replace tie rods. (Job Sheet #1)

    b. Remove and replace ski skegs. (Job Sheet #2)

    c. Adjust ski alignment on a snowmobile. (Job Sheet #3)

STEERING, FRONT SUSPENSION AND SKIS
UNIT II

ANSWERS TO TEST

1. a. 3
   b. 12
   c. 10
   d. 7
   e. 5
   f. 8
   g. 2
   h. 1
   i. 13
   j. 9
   k. 6
   l. 4
   m. 11

2. a. Controls
   b. Handlebars
   c. Handlebars
   d. Skis
   e. Movement
   f. Not restricted
   g. Adversely
   h. Checked

3. a, c

4. a. Steering
   b. Cushion
   c. 1) Leafspring
      2) Independent
      3) Strut

5. a. Steel
   b. Shock absorber
   c. Leafsprings
   d. 1) Body
      2) Plunger
      3) Resistance
      4) Lubricant

6. b, c

7. a. Leafspring
   b. Yamaha
   c. Aircraft
   d. Nitrogen
   e. Shock absorber
   f. Longer

ANSWERS TO TEST

8. a. Leafspring
   b. Independent
   c. Strut

9. a,b,c,e,g

10. b, c, d, f, g

11. Evaluated to the satisfaction of the instructor

12. Performance skills evaluated according to procedures written in the job sheets

DRIVE CLUTCH
UNIT III

UNIT OBJECTIVE

After completion of this unit, the student should be able to discuss the power theory and other unique elements of snowmobile transmissions. The student should also be able to remove, inspect, and replace a drive clutch. These competencies will be evidenced by correctly performing the procedures outlined in the assignment and job sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to the drive clutch with their correct definitions.
2. Identify drive clutch components.
3. Complete statements concerning power theory.
4. Select true statements concerning clutch wear.
5. Complete statements concerning lubrication and cleaning.
6. Complete statements concerning clutch adjustment.
7. Select true statements concerning troubleshooting.
8. Complete statements concerning special tools.
9. Select true statements concerning clutch timing.
10. Solve problems related to drive clutch wear. (Assignment Sheet #1).
11. Demonstrate the ability to remove, inspect, and replace a drive clutch. (Job Sheet #1)

DRIVE CLUTCH
UNIT III

SUGGESTED ACTIVITIES

A. Provide students with objective sheet.

B. Provide students with information sheet.

C. Make transparency.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Demonstrate and discuss the procedures outlined in the job sheets.

G. Have a disassembled clutch available so students can examine components.

H. Explain to students the relationships of the drive clutch, drive belt, and driven clutch, and explain why job sheets for adjusting offset, center distance, and parallelism will not be assigned until they have finished the next two units which cover drive belts and driven clutches.

I. Mount a snowmobile on a safety stand and conduct a quick-check inspection for transmission engagement, idle disengagement, and discuss possible causes of poor performance.

J. Demonstrate how springs, weights, and ramps affect clutch timing.

K. Give test.

CONTENTS OF THIS UNIT

A. Objective sheet

B. Information sheet

C. Transparency Master 1 — Drive Clutch

D. Assignment Sheet #1 — Solve Problems Related to Drive Clutch Wear

E. Answers to assignment sheet

F. Job Sheet #1 — Remove, Inspect, and Replace a Drive Clutch

G. Test

H. Answers to test

REFERENCES USED IN DEVELOPING THIS UNIT

A. *1986 Yamaha Snowmobile Mechanics Guide*. Cypress, CA: Yamaha Motor Corporation, U.S.A., 1985.

B. *Arctic Cat Master Service Training Manual*. Thief River Falls, MN 56701: Arctic Cat, 1986.

C. *Chilton's Snowmobiles Repair & Tune-Up Guide*, Second Edition. Radnor, PA: Chilton Book Company, 1975.

D. *Bombardier Service Tapes: Clutches*. Valcourt, Quebec, Canada, JOE 2L0: Bombardier, Ltd, 1985.

E. *Kawasaki Drifter Snowmobile Shop Manual*. Santa Ana, CA 92799-5252: Kawasaki Motors Corp., U.S.A., 1980.

F. *Kawasaki Parts Catalog SB340-A2, SB440-A5*. Santa Ana, CA 92799-5252: Kawasaki Motors Corp., U.S.A., 1980.

DRIVE CLUTCH
UNIT III

INFORMATION SHEET

I. **Terms and definitions**

A. Drive clutch — The primary clutch attached to the engine crankshaft which controls the upshift in acceleration (also called the centrifugal drive clutch or drive converter)

B. Driven clutch — The variable ratio clutch or torque converter that is mounted to the driven shaft where its torque-sensing capabilities transfers power to the track

C. Drive assembly — The drive clutch, the drive belt, and the driven clutch that work together to transfer power from the engine to the track

D. Stationary sheave — The clutch sheave that remains in one position during operation of the drive or driven clutch

E. Movable sheave — The clutch face that moves inward or outward to create variable ratios in the drive and driven clutches

F. Centrifugal weights — Moving clutch parts that force the movable sheave of the drive clutch inward to increase the diameter of the drive clutch

G. Centrifugal force — The force that tends to pull mass outward from the center when the mass is rotating rapidly around a center

H. Offset — The positioning of the drive and driven clutch so that the belt will run straight between the clutches when the transmission ratio is at or near 1 to 1 (1:1)

I. Spider — The assembly to which the weight-assembly ramps or rollers are attached and which in turn is fixed onto the clutch shaft

J. Spring — A wire coil that exerts a force which is countered by the centrifugal force of the weights in the drive clutch

K. Roller — The surface which receives the force exerted by the weight-assembly ramp

L. Spring free length — The length of a spring as measured when the spring is unloaded

M. Spring preload — The creation of a given amount of tension on a spring, achieved by compressing the spring

N. Center distance — The distance from the center of the engine crankshaft to the center of the driven shaft.

INFORMATION SHEET

O. Parallelism — A straight or parallel relationship between the engine crankshaft and the driven shaft.

P. Shim — A metal-type washer.

II. **Drive clutch components** (Transparency 1)

A. Stationary sheave

B. Movable sheave

C. Weight ramp assemblies (usually 3)

D. Ramp

E. Spring

F. Cover assembly

G. Spider

H. Roller (and bearing)

I. Bushing

III. **Power theory**

A. A centrifugal clutch system engages or disengages the engine from the track with centrifugal force.

B. The centrifugal force is the source of the automatic action of a snowmobile's transmission.

C. A system of levers and cams are located inside the drive clutch's outer half, the movable sheave.

D. The levers and cams move the movable sheave of the drive clutch inward when the engine reaches a predetermined speed.

(NOTE: This point of activation is determined and set at the factory for maximum efficiency of the drive system; altering or inattention to the index marks which denote alignment of this point can alter the efficiency of the drive system.)

E. The inner half of the drive clutch, the stationary sheave, rotates with the engine's crankshaft.

F. The outer half of the drive clutch, the movable sheave, includes the outer half of the pulley on the engine which drives the drive belt.

INFORMATION SHEET

G. At low rpm's, the stationary and movable sheaves are forced apart by the clutch spring and the clutch spins freely and does not engage the drive belt.

H. When engine rpm's increase, the stationary and movable sheaves are pressed together because of the centrifugal force of the clutch weights, and the sheaves grip the sides of the drive belt to engage the drive system and set the sled in motion

I. Some slippage of the drive belt can be expected as the two drive clutch sheaves come together, but the slight delay of engagement gives a fluid-like power flow and avoids jerky starts.

J. The combination of weights, spring tension, and rpm's control the amount of pressure exerted between the clutch sheaves, and consequently, the amount of power transmitted to the track.

IV. **Clutch wear**

A. Before disassembling a clutch, note all index marks, and if no index marks are present, mark the clutch sheaves with a magic marker to assure proper reassembly

B. The drive clutch should be inspected at least annually.

C. Always inspect the spring which separates the stationary and movable sheaves, and if its length is not as specified, it should be replaced.

D. General maintenance of the drive clutch should include an inspection of the sheaves for burrs or obstructions which could cause premature belt wear.

E. Bushings are the most susceptible to wear since they are in constant friction with other moving parts.

F. Bushings should be checked for wear by measuring the inside diameter of the bushing with the outside diameter of the part it contacts.

G. Always inspect the two sheaves for cracks and replace them if necessary.

H. The weights are susceptible to damage and wear.

I. All threads on the drive clutch and its components should be inspected for stripping and for cracks.

J. All rollers and pins, washers, and shims should be inspected for damage or wear.

INFORMATION SHEET

V. **Lubrication and cleaning**

A. Many snowmobiles feature clutches with synthetic fiber bushings which require no lubrication

B. Always follow manufacturer specifications for lubricating the moving components of the drive clutch.

C. Excess lubrication is a major cause of belt slippage and abnormal wear.

D. Some models use Duralon bushings on components of the drive clutch, and these bushings require no lubrication.

E. Always clean sheave faces and shaft with fine steel wool and a dry cloth, and clean the movable sheave bushing with a dry cloth only.

VI. **Clutch adjustment**

A. Snowmobile performance depends on proper adjustment of the transmission system.

B. Adjustment of the transmission requires the alignment of the drive clutch with the driven clutch.

C. Inspection of the alignment should be done periodically, before long trips, and anytime the engine has been removed and replaced.

D. Improper alignment can result in improper belt wear and damage, and significant reduction in the amount of horsepower delivered to the track.

E. Checking the offset dimension is the initial procedure in alignment of the drive clutch/driven clutch relationship.

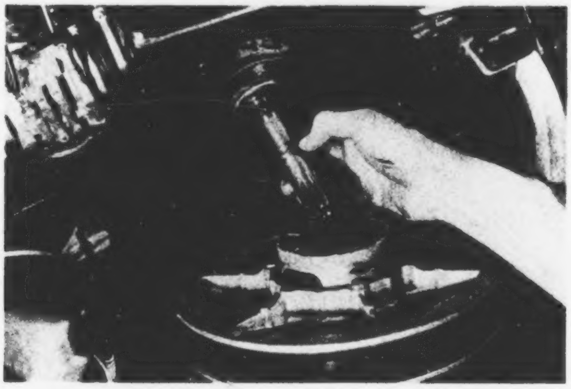
1. The offset dimension varies from model to model depending on the drive clutch and driven clutch types and manufacturers.

2. Proper offset measurement allows the belt to run straight between the drive clutch and driven clutch when the system reaches a near 1:1 shift ratio.

INFORMATION SHEET

3. Offset can be adjusted by moving the driven clutch on the driven clutch shaft, and removing or adding shims as required (Figure 1).

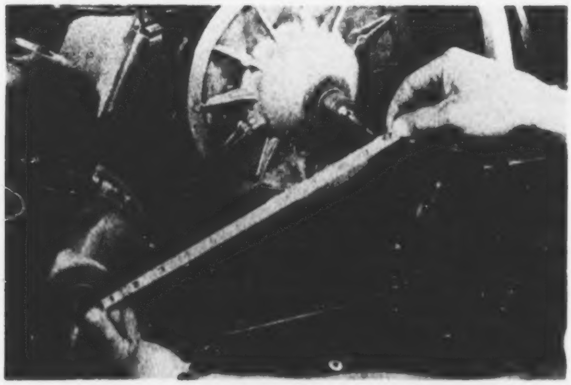
FIGURE 1



F. The drive clutch/driven clutch center distance is the second adjustment procedure in alignment.

1. Center distance affects the drive belt length and the effective ratios of the belt in shifting (Figure 2).

FIGURE 2



INFORMATION SHEET

2. Center distance is set at the factory, and in most cases, no adjustments are possible.

3. Center distance adjustments may be possible by adding or reducing the number of shims on the motor mounting system, or by slight adjustment of chain case components.

G. When the crankshaft to which the drive clutch is attached, and the driven clutch are parallel, the drive clutch and driven clutch sheaves also will be parallel.

1. Parallelism allows for efficient power transfer to the track.

2. Engine torque can cause misalignment of the two clutch sheaves because the engine is cushion mounted.

3. Some intentional misalignment is acceptable because under power, engine torque will tend to bring the sheaves into parallel.

4. Manufacturer's service manuals provide details on how to inspect and adjust for parallelism.

H. Higher altitude operation requires adjustments to the transmission system.

1. Engines lose about three percent of their horsepower for every 1,000 foot rise in elevation from sea level because of a decrease in the density of oxygen.

2. Higher altitude operation requires adjustments to both the carburetor and the transmission.

3. Consult service manuals for the specific drive system adjustments which should be made while operating in higher altitude environments.

VII. **Troubleshooting**

A. A thorough understanding of each component of the drive system is essential in troubleshooting to discover the causes of malfunctions.

B. Troubleshooting requires a rational and systematic approach to the diagnosis and repair of drive system malfunctions.

C. There are five precautions which must be taken in troubleshooting:

1. Never allow anyone to stand behind or in front of the snowmobile when running the engine and testing the drive system.

2. Always raise the track off the ground so the track can rotate freely.

INFORMATION SHEET

3. Never run the engine while the drive belt is removed.

4. Always wait for all moving parts to stop after stopping the engine before making any drive clutch adjustments.

5. Keep all safety shields or covers in place and securely fastened.

D. Develop a troubleshooting list which should include:

1. Check for proper alignment of the drive clutch and driven clutch for offset, center distance, and parallelism.

2. Inspect the stationary and movable sheave faces and clean off all dirt, oil, grease, and belt dust buildup.

3. Gouges, scratches, nicks or corrosion on the sheave faces should be removed by sanding with 400 grit wet-or-dry sandpaper.

4. With the track raised off the floor and the engine idling, the track should not move, or if the track does move, slight pressure on the brake lever should stop it.

5. Run the engine with the drive system engaged for 30 seconds then release the throttle lever; the drive clutch should disengage immediately.

E. The idle speed of the snowmobile may be too high if the drive clutch does not disengage upon release of the throttle lever, or the drive clutch spring may be weak, or the drive clutch may be dirty.

F. If the drive clutch does not engage, or engages at too high rpm, the wrong drive clutch spring may have been installed or weights too light may have been installed.

VIII. **Special tools**

A. Each model and make of snowmobile may require special tools for assembling and disassembling and aligning components of the drive system.

B. Always use the specified puller to remove the sheaves of the drive clutch or else serious damage could result to the sheave.

C. Use calipers for measuring wear on bushings and other components.

D. Heating may be necessary to remove lugs or nuts held with LOCKTITE adhesive.

E. Some models have special tools for measuring center distance, offset, and parallelism.

INFORMATION SHEET

IX. Clutch timing

A. The spring between the two sheaves has a major influence over the engagement speed:

1. When the spring tension is weak there is a lower engagement speed and a slightly lower full throttle rpm.

2. When the spring tension is strong there is a higher engagement speed and a slightly higher engine rpm at full throttle.

B. Weights attached to the spider or the moving sheave control rpm through the complete shifting process:

1. Light weights cause a higher engine rpm to be needed for initial clutch engagement , and a slightly higher engine rpm for any given vehicle speed.

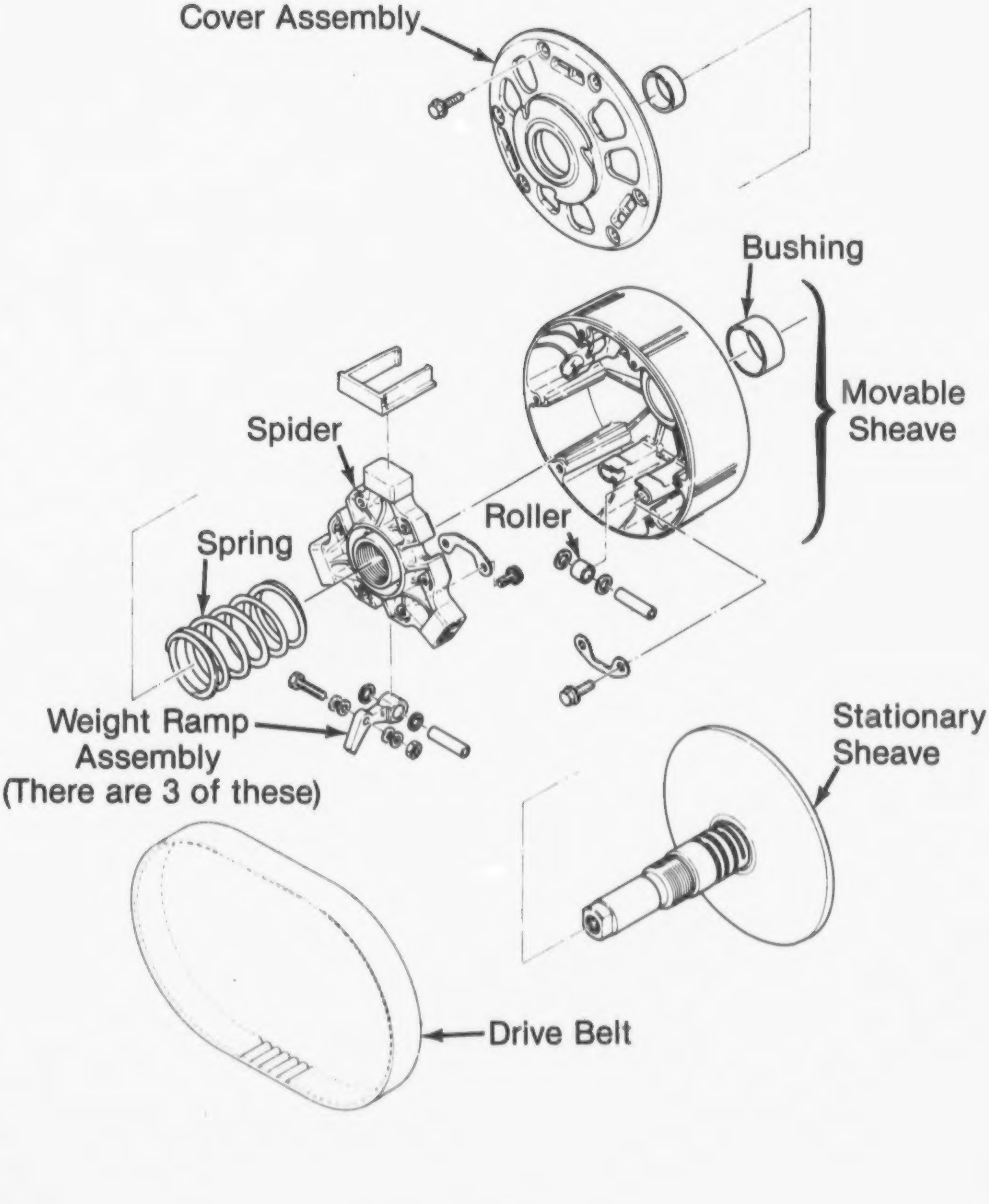
2. Heavy weights lower the engine rpm for initial clutch engagement and cause lower engine rpm at any given vehicle speed.

C. Ramps attached to the moving sheave affect engagement, mid-range shifting and full shifting.

1. A steep ramp angle will significantly increase engine rpm.

2. A more gradual incline in ramp angle will decrease engine rpm.

Drive Clutch


Cover Assembly
Bushing
Movable Sheave
Spider
Roller
Spring
Weight Ramp Assembly (There are 3 of these)
Stationary Sheave
Drive Belt

Courtesy Kawasaki Motors Corp., U.S.A.

DRIVE CLUTCH
UNIT III

ASSIGNMENT SHEET #1 — SOLVE PROBLEMS RELATED TO DRIVE CLUTCH WEAR

Directions: Read the following problems carefully and recommend the best solution.

A. You have been directed to disassemble a drive clutch to inspect it for signs of wear; what specific, critical items, are most important in this inspection?

____

____

B. You have difficulty in removing nuts during disassembly; what might you suspect and what should you look for?

____

____

C. A customer enters the repair shop where you work and complains that the transmission engages at too high an rpm, what source of wear might be the cause of the problem?

____

____

DRIVE CLUTCH
UNIT III

ANSWERS TO ASSIGNMENT SHEET #1

A. Begin by checking index marks to assure proper reassembly, then check for weights, roller, and pin wear because they are subjected to constant friction wear during clutch operation. Check the spring for damage or improper free length, and inspect the sheave for burrs or rust.

B. Whoever disassembled and reassembled the clutch last may have improperly torqued the nuts. Inspect the threads of all components for wear and damage due to over-torquing, and then replace and torque to the specifications required by the manufacturer.

C. Excessive wear or grooving of the ramp surface may have reduced the effectiveness of the weights of the drive clutch; they should be disassembled and inspected for excessive wear and replaced if necessary. The spring should also be checked to make sure it is the correct spring, and that spring free length meets specifications. Check for bushing wear.

DRIVE CLUTCH
UNIT III

JOB SHEET #1 — REMOVE, INSPECT, AND REPLACE A DRIVE CLUTCH

A. Tools and materials

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Basic hand tools
4. Drive clutch puller
5. Torque wrench
6. Impact wrench
7. Feeler gauge
8. Clean shop towels
9. Replacement parts as required
10. Safety glasses

B. Procedure

1. Put on safety glasses
2. Secure the sled in a safe work area, and remove the engine cover, clutch guard, and drive belt

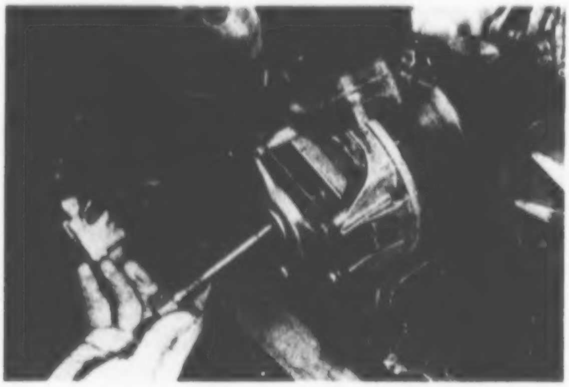
   (NOTE: Check Job Sheet #1, Unit IV for correct drive belt removal.)

3. Remove the drive clutch securing bolt with an impact wrench

JOB SHEET #1

4. Remove the drive clutch with the proper puller (Figure 1)

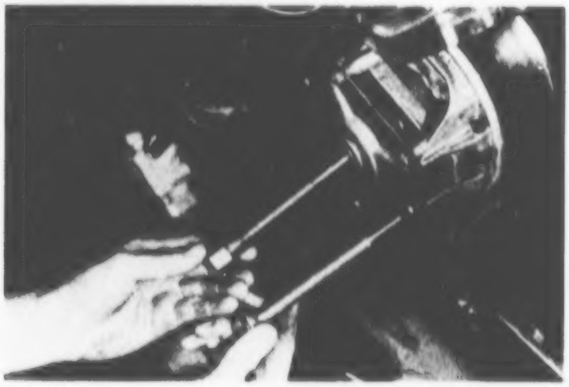
FIGURE 1



5. Use the correct puller and do not attempt to use the drive clutch securing bolt as a puller because you will waste time and perhaps damage the clutch (Figure 2)

(NOTE: The drive clutch securing bolt will not function as a puller because it screws into the drive shaft and will not screw into the clutch stationary sheave as a puller must; the proper puller is shown on the left in Figure 2 and the securing bolt is shown on the right.)

FIGURE 2

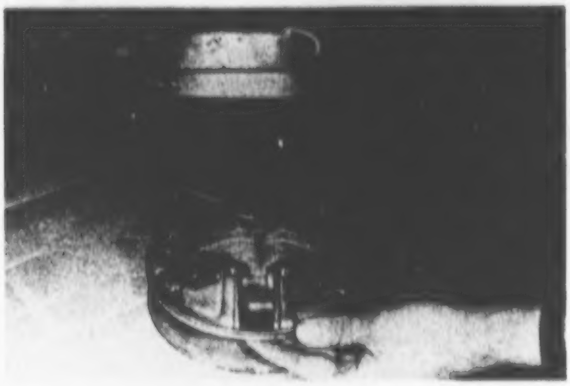


JOB SHEET #1

6. Take the drive clutch to a workbench

7. Remove the drive clutch cover with care so the spring won't fly out and strike you (Figure 3)

FIGURE 3



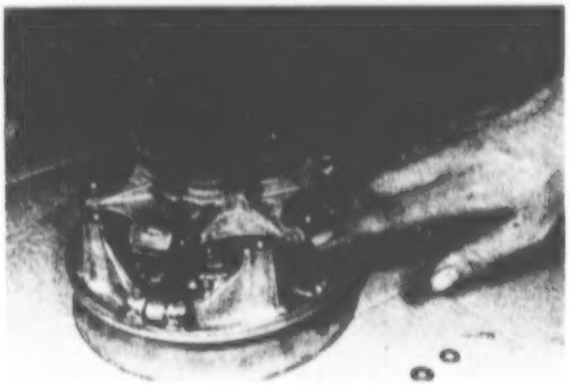
8. Inspect the rollers and pins in the clutch spider for wear, and replace as required (Figure 4)

FIGURE 4

JOB SHEET #1

9. Inspect the Duralon bushings that help support the spider, and make sure they are not worn to the point they will permit too much spider play (Figure 5)

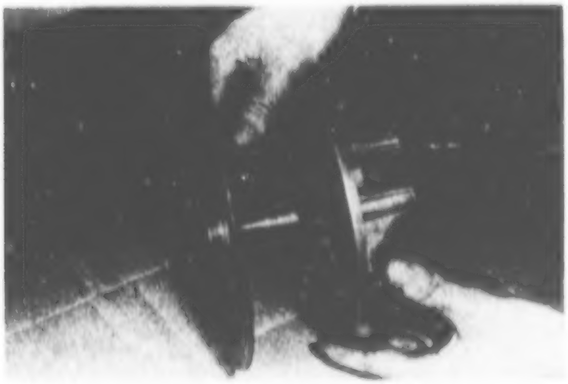
FIGURE 5



10. Replace any bushings that are worn out

11. Spread the stationary sheaves from the movable sheave and measure the bushing clearance with a feeler gauge (Figure 6)

FIGURE 6



JOB SHEET #1

12. Check the bushing clearance measurement with manufacturer's specifications, and replace the bushing if it is worn beyond wear limits

13. Inspect the sheaves for burrs, rust, or any damage that might promote premature belt wear, and clean the sheaves with a clean, dry shop towel

14. Measure spring free length with calipers and make sure it is within wear limits

☐ Have your instructor check your work

15. Reassemble the drive clutch unit by reversing the disassembly procedure, and be sure to torque all nuts and bolts to specifications

16. Replace the drive clutch on the sled, and torque the securing bolt to specifications

17. Replace drive belt, clutch guard, and engine cover

☐ Have your instructor check your work

18. Clean up area and return tools and materials to proper storage

DRIVE CLUTCH
UNIT III

NAME ____________________

TEST

1. Match terms related to the drive clutch with their correct definitions.

_____a. The primary clutch attached to the engine crankshaft which controls the upshift in acceleration

_____b. The variable ratio clutch or torque converter that is mounted to the driven shaft where its torque-sensing capabilities transfers power to the track

_____c. The drive clutch, the drive belt, and the driven clutch that work together to transfer power from the engine to the track

_____d. The clutch sheave that remains in one position during operation of the drive or driven clutch

_____e. The clutch face that moves inward or outward to create variable ratios in the drive and driven clutches

_____f. Moving clutch parts that force the movable sheave of the drive clutch inward to increase the diameter of the drive clutch

_____g. The force that tends to pull mass outward from the center when the mass is rotating rapidly around a center

_____h. The positioning of the drive and driven clutch so that the belt will run straight between the clutches when the transmission ratio is at or near 1 to 1

_____i. The assembly to which the weight-assembly ramps or rollers are attached and which in turn is fixed onto the clutch shaft

_____j. A wire coil that exerts a force which is countered by the centrifugal force of the weights in the drive clutch

_____k. The surface which receives the force exerted by the weight-assembly ramp

1. Centrifugal force
2. Shim
3. Centrifugal weights
4. Parallelism
5. Drive clutch
6. Offset
7. Center distance
8. Movable sheave
9. Spring preload
10. Driven clutch
11. Spring free length
12. Drive assembly
13. Roller
14. Stationary sheave
15. Spider
16. Spring

TEST

_____l. The length of a spring as measured when the spring is unloaded

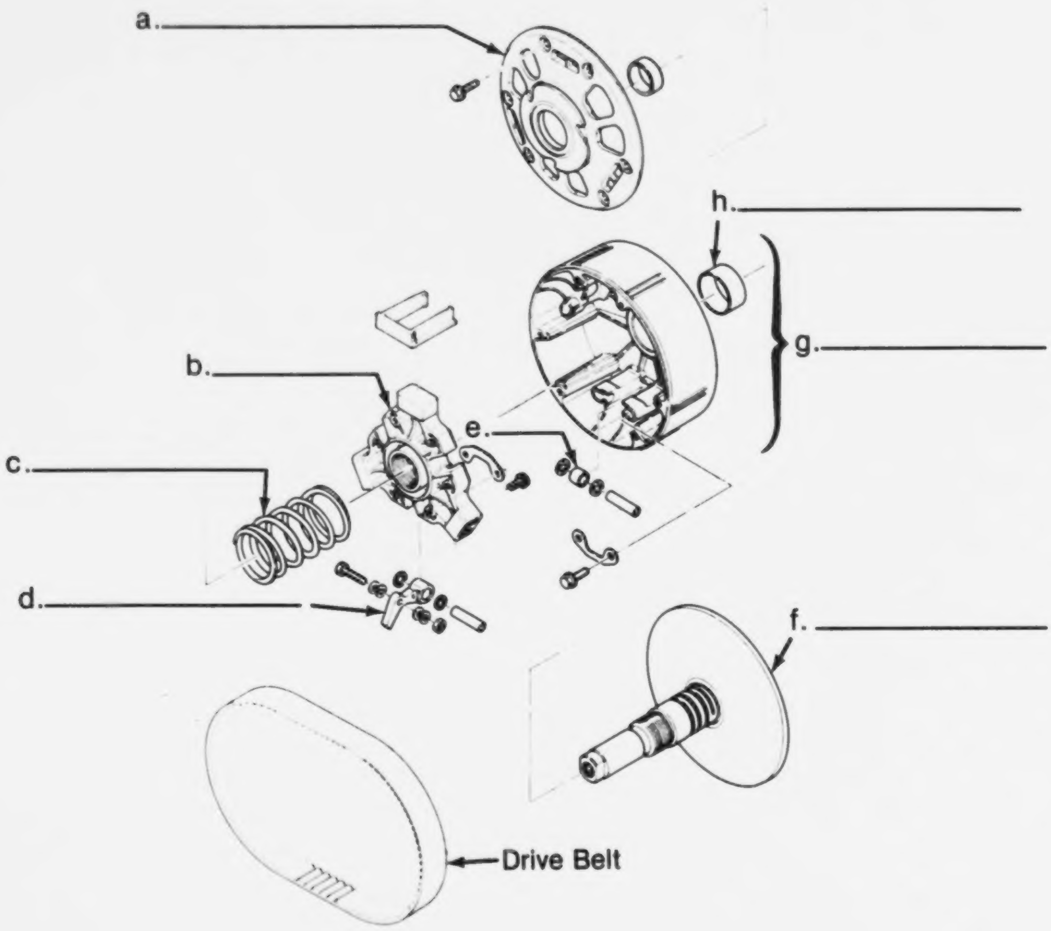
_____m. The creation of a given amount of tension on a spring, achieved by compressing the spring

_____n. The distance from the center of the engine crankshaft to the center of the driven shaft

_____o. A straight or parallel relationship between the engine crankshaft and the driven shaft

_____p. A metal-type washer

2. Identify parts of a drive clutch by inserting the proper component name in the appropriate blank.



TEST

3. Complete statements concerning power theory by circling the word(s) that best completes each statement.

   a. A centrifugal clutch system engages or disengages the (**steering, engine**) from the track with centrifugal force.

   b. The centrifugal force is the source of the (**manual, automatic**) action of a snowmobile's transmission.

   c. A system of levers and cams are located inside the drive clutch's outer half, the (**movable, stationary**) sheave.

   d. The levers and cams move the movable sheave of the drive clutch (**outward, inward**) when the engine reaches a predetermined speed.

   e. The inner half of the drive clutch, the stationary sheave, rotates with the engine's (**pistons, crankshaft**).

   f. The outer half of the drive clutch, the movable sheave, includes the outer half of the pulley on the (**engine, clutch**) which drives the drive belt.

   g. At low rpm's, the stationary and movable sheaves are forced apart by the clutch spring and the clutch spins freely and (**does, does not**) engage the drive belt.

   h. When engine rpm's increase, the stationary and movable sheaves are pressed together because of the centrifugal force of the clutch weights, and the sheaves grip the (**bottom, sides**) of the drive belt to engage the drive system and set the sled in motion.

   i. Some slippage of the drive belt (**can, cannot**) be expected as the two drive clutch sheaves come together, but the slight delay of engagement gives a fluid-like power flow and avoids jerky starts.

   j. The combination of weights, spring tension, and rpm's control the amount of pressure exerted between the clutch sheaves, and consequently, the amount of power transmitted to the (**drive clutch, track**).

4. Select true statements concerning clutch wear by placing an "X" beside each statement that is true.

   _____a. The drive clutch should be inspected at least annually.

   _____b. Always inspect the spring which separates the stationary and movable sheaves, and if its length is not as specified, it should be replaced.

   _____c. General maintenance of the drive clutch should not include an inspection of the sheaves for burrs or obstructions which could cause premature belt wear.

TEST

_____d. Bushings are the least susceptible to wear since they are not in constant friction with other moving parts.

_____e. Bushings should be checked for wear by measuring the inside diameter of the bushing with the outside diameter of the part it contacts.

_____f. Always inspect the two sheaves for cracks and replace them if necessary.

_____g. The weights are not susceptible to damage and wear.

_____h. All threads on the drive clutch and its components should be inspected for stripping and for cracks.

_____i. All rollers and pins, washers, and shims should be inspected for damage or wear.

_____j. There are no index marks to worry about on a drive clutch.

5. Complete statements concerning lubrication and cleaning by inserting the word(s) that bes completes each statement.

   a. Many snowmobiles feature clutches with _______________ bushings which require no lubrication

   b. Always follow _________________ specifications for lubricating the moving components of the drive clutch.

   c. _____________ lubrication is a major cause of belt slippage and abnormal wear.

   d. Most models use _____________ bushings on components of the drive clutch, and these bushings require no lubrication.

   e. Always clean clutch faces and shaft with _____________ _____________ _____________and a dry cloth, and clean the movable sheave bushing with a dry cloth only.

6. Complete statements concerning clutch adjustment by circling the word(s) that best completes each statement.

   a. Snowmobile performance depends on proper adjustment of the (**transmission, brake**) system.

   b. Adjustment of the transmission requires the alignment of the (**jack shaft, drive clutch**) with the driven clutch.

   c. Inspection of the alignment should be done periodically, (**after, before**) long trips, and anytime the engine has been removed and replaced.

   d. Improper alignment can result in improper belt wear and damage, and significant (**increase, reduction**) in the amount of horsepower from the engine.

TEST

e. Checking the offset dimension is the (**final, initial**) procedure in alignment of the drive clutch/driven clutch relationship.

   1) The offset dimension (**varies, never varies**) from model to model depending on the drive clutch and driven clutch types and manufacturers.

   2) Proper offset measurement allows the (**belt, crankshaft**) to run straight between the drive clutch and driven clutch when the system reaches a near 1:1 shift ratio.

   3) Offset can be adjusted by moving the driven clutch on the driven clutch shaft, and removing or adding (**washers, shims**) as required.

f. The drive clutch/driven clutch center distance is the (**first, second**) adjustment procedure in alignment.

   1) Center distance affects the drive belt (**length, width**) and the effective ratios of the belt in shifting.

   2) Center distance is set at the factory and, in most cases, (**adjustments, no adjustments**) are possible.

   3) Center distance adjustments may be possible by adding or reducing the number of shims on the motor mounting system or by slight adjustment of (**chain case components, drive clutch components**).

g. When the crankshaft to which the drive clutch is attached, and the driven clutch are parallel, the drive clutch and driven clutch sheaves (**will not be, also will be**) parallel.

   1) Parallelism allows for (**rapid, efficient**) power transfer to the track.

   2) Torque by the engine can cause (**alignment, misalignment**) of the two clutch sheaves.

   3) Some misalignment is (**acceptable, not acceptable**) because under power the engine torque will tend to bring the sheaves into parallelism.

   4) Manufacturer's service manuals provide (**details, no details**) on how to inspect and adjust for parallelism.

h. Higher altitude operation requires (**adjustments, no adjustments**) to the transmission system.

   1) Engines (**gain, lose**) about three percent of their horsepower for every 1,000 foot rise in elevation from sea level because of a decrease in the density of oxygen.

   2) Higher altitude operation requires (**adjustments, no adjustments**) to both the carburetor and the transmission.

   3) Consult service manuals for the specific drive system adjustments which should be made while operating in (**higher altitude, all**) environments.

TEST

7. Select true statements concerning troubleshooting by placing an "X" beside each statement that is true.

(NOTE: For a statement to be true, all parts of the statement must be true.)

_____a. A minimum understanding of each component of the drive system is essential in troubleshooting to discover the causes of malfunctions.

_____b. Troubleshooting requires a rational and systematic approach to the diagnosis and repair of drive system malfunctions.

_____c. There are six precautions which must be taken in troubleshooting:

1) Never allow anyone to stand behind or in front of the snowmobile when running the engine and testing the drive system.

2) Never raise the track off the ground so the track can rotate freely

3) Occasionally run the engine while the drive belt is removed.

4) Always wait for all moving parts to stop after stopping the engine before making any drive clutch adjustments.

5) Keep all safety shields or covers in place and securely fastened.

_____d. Develop a troubleshooting list which should include:

1) Check for proper alignment of the drive clutch and driven clutch for offset, center distance, and parallelism.

2) Inspect the stationary and movable sheave faces and clean off all dirt, oil, grease, and belt dust buildup.

3) Gouges, scratches, nicks or corrosion on the sheave faces should not be removed by sanding with 400 grit wet-or-dry sandpaper.

4) Do not raise the track off the floor and allow it to idle.

5) Run the engine with the drive system engaged for 30 seconds then release the throttle lever; the drive system should disengage immediately.

_____e. The idle speed of the snowmobile may be too low if the drive system does not disengage upon release of the throttle lever, or the drive clutch spring may be weak, or the drive clutch may be dirty.

_____f. If the drive system does not engage, or engages at too high rpm, the wrong clutch spring may have been installed, or weights too light may have been installed.

TEST

8. Complete statements about special tools by inserting the word(s) that best completes each statement.

   a. Each model and make of snowmobile may require special ____________ for assembling and disassembling and aligning components of the drive system.

   b. Always use the ____________ puller to remove the sheaves of the drive clutch or else serious damage could result to the sheave.

   c. Use ____________ for measuring wear on bushings and other components.

   d. ____________ may be necessary to remove lugs or nuts held with LOCTITE adhesive.

   e. Some models have special tools for measuring ____________, offset, and parallelism.

9. Select true statements concerning clutch timing by placing an "X" beside each statement that is true.

   (NOTE: For a statement to be true, all parts of the statement must be true.)

   _____a. The spring between the two sheaves has a major influence over the engagement speed.

   1) When the spring tension is weak there is a lower engagement speed and a slightly lower full throttle rpm.

   2) When the spring tension is strong there is a lower engagement speed and a slightly higher engine rpm at full throttle.

   _____b. Weights attached to the spider of the moving sheave control rpm through the complete shifting process.

   1) Light weights cause a lower rpm and a slightly higher engagement speed.

   2) Heavy weights lower the engine rpm and create a slightly lower engagement.

   _____c. Ramps attached to the moving sheave affect engagement, mid-range shifting and full shifting.

   1) A steep ramp angle will significantly increase rpms.

   2) A more gradual decline in ramp angle will decrease rpms.

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

10. Solve problems related to drive clutch wear. (Assignment Sheet #1)

11. Demonstrate the ability to remove, inspect, and replace a drive clutch. (Job Sheet #1)

DRIVE CLUTCH
UNIT III

ANSWERS TO TEST

1. a. 5
   b. 10
   c. 12
   d. 14
   e. 8
   f. 3
   g. 1
   h. 6
   i. 15
   j. 16
   k. 13
   l. 11
   m. 9
   n. 7
   o. 4
   p. 2

2. a. Cover assembly
   b. Spider
   c. Spring
   d. Weight ramp assembly
   e. Roller
   f. Stationary sheave
   g. Movable sheave
   h. Bushing

3. a. Engine
   b. Automatic
   c. Movable
   d. Inward
   e. Crankshaft
   f. Engine
   g. Does not
   h. Sides
   i. Can
   j. Track

4. a, b, e, f, h, i

5. a. Synthetic fiber
   b. Manufacturer's
   c. Excess
   d. Duralon
   e. Fine steel wool

6. a. Transmission
   b. Drive clutch
   c. Before
   d. Reduction
   e. Initial
      1) Varies
      2) Belt
      3) Shims

ANSWERS TO TEST

- f. second
  - 1) Length
  - 2) No adjustments
  - 3) Chain case components
- g. Also will be
  - 1) Efficient
  - 2) Misalignment
  - 3) Acceptable
  - 4) Details
- h. Adjustments
  - 1) Lose
  - 2) Adjustments
  - 3) Higher altitude

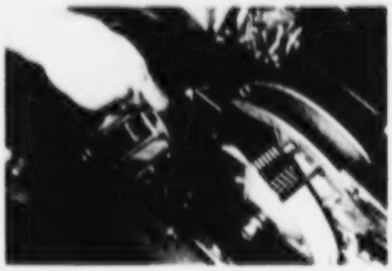
7. b, f

8. a. Tools
   b. Specified
   c. Calipers
   d. Heating
   e. Center distance

9. c

10. Evaluated to the satisfaction of the instructor

11. Performance skills evaluated according to procedures written in the job sheet



DRIVE BELTS
UNIT IV

UNIT OBJECTIVE

After completion of this unit, the student should be able to discuss drive belt operations and how a drive belt functions in a transmission system. The student should also be able to remove and install a drive belt. These competencies will be evidenced by correctly performing the procedures outlined in the assignment and job sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to drive belts with their correct definitions.
2. Complete statements concerning drive belt principles.
3. Complete statements concerning drive belt installation.
4. Match common causes of drive belt failure with ways to avoid them.
5. Complete statements concerning transmission and drive belt relationships.
6. Select true statements concerning drive belt alignment.
7. Select true statements concerning drive belt manufacturers.
8. Complete statements concerning troubleshooting belt failures.
9. Solve problems related to drive belts and transmissions. (Assignment Sheet #1)
10. Demonstrate the ability to remove and install a drive belt. (Job Sheet #1)

DRIVE BELTS
UNIT IV

SUGGESTED ACTIVITIES

A. Provide students with objective sheet.

B. Provide students with information sheet.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Demonstrate and discuss the procedures outlined in the job sheet.

G. Job sheets for checking offset, center distance, and parallelism appear in the Driven Clutch unit that follows this one, but you may want to review those procedures at this time, or have the students perform those jobs sheets with this unit.

H. Remove the belt guard from a snowmobile and check for belt wear, and talk about how belt wear can be a clue to other problems.

I. Give test.

CONTENTS OF THIS UNIT

A. Objective sheet

B. Information sheet

C. Assignment Sheet #1 — Solve Problems Related to Drive Clutch Wear

D. Answers to assignment sheet

E. Job Sheet #1 — Remove and Install a Drive Belt

F. Test

G. Answers to test

REFERENCES USED IN DEVELOPING THIS UNIT

A. *Gates Sportline® Belt Applications Catalog (No. 31-2070).* Denver, CO 80217: The Gates Rubber Co., 1984.

B. *Theory: Snowmobile Drive System.* Thief River Falls, MN 56701: Arctic Enterprises, Inc., 1983.

C. *1980 Bombardier Snowmobiles Shop Manual.* Valcourt, Quebec, Canada: Bombardier, Ltd., 1979.

D. *1986 Yamaha Snowmobile Mechanics Guide.* Cypress, CA: Yamaha Motor Corporation, U.S.A., 1985.

DRIVE BELTS
UNIT IV

INFORMATION SHEET

I. **Terms and definitions**

   A. Drive belt — Rubber and fabric belt used to transfer power from the drive clutch to the driven clutch

   B. Belt disintegration — The deterioration of a drive belt to the point where excessive belt speed or dirty sheaves will cause the belt to come apart while the snowmobile is in operation

   C. Cords — Heavy reinforcement material molded into the drive belt to give the belt strength and long life

   D. Cogs — Ridge-like indentations on the underside of a belt which allow flexibility in wrapping the belt on the sheaves

   E. Belt ride out — When the belt overrides the clutch sheaves because the belt is too long or the clutches are too close together

   F. Sidewalls — The sides of the drive belt through which torque is transmitted

II. **Drive belt principles**

   A. Drive belts have two components which affect drive system performance.

      1. Drive belt dimensions must be matched to the snowmobile at the factory, both width and circumference.

      2. Drive belt construction influences the way the clutches shift, and the amount of power that will be transmitted through the drive system.

   B. In addition to the construction of the drive belt, the length of the belt plays an important part in drive system performance.

   C. A drive belt too long will not have a full shift ratio available to the clutches, and will cause poor acceleration and a loss in top speed.

   D. A drive belt too thin will have the same effect as a belt that is too long.

   E. A drive belt which is too short will influence shifting and the amount of power transmitted through the drive system, causing different shift patterns than specified for the machine.

   F. There is no specific time or mileage at which a drive belt suddenly wears out or fails.

INFORMATION SHEET

G. With proper maintenance a drive belt can last a winter season.

H. Many manufacturers recommend that drive belts be inspected at least twice a year.

I. Drive belt improvements through the years have helped increase snowmobile performance.

(NOTE: Older belts could not have handled the 80 mph speeds registered by some modern snowmobiles.)

III. **Drive belt installation**

A. When removing a drive belt that will later be reinstalled, mark the direction of belt travel and reinstall the belt so that it will rotate in the same direction. (Figure 1)

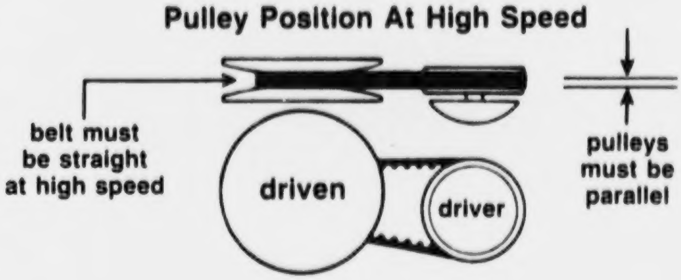
FIGURE 1

B. Never install a drive belt with the ignition switch on.

INFORMATION SHEET

C. Keep the motor mounts and the chain case rigid at all times to insure proper clutch alignment. (Figure 2)

FIGURE 2


Pulley Position At High Speed
belt must be straight at high speed
driven
driver
pulleys must be parallel

Courtesy the Gates Rubber Company

D. Never pry a drive belt off or onto a clutch.

E. Always replace the belt guard before operating the sled.

IV. **Common causes of drive belt failure and ways to avoid them**

A. Heat — This number one cause of belt failure can be avoided by proper belt selection, proper clutch alignment, and proper operation.

B. Clutch misalignment — Since proper alignment is critical to both performance and belt life, inspect for correct offset, center distance, and parallelism when inspecting or installing a belt.

C. Cold belt — Belt life is dramatically reduced if the belt is not properly warmed up before shifting into high speed conditions, so run the sled awhile before speed runs.

D. Seasonal oversight — Failure to check belt alignment before or after summer storage may also cause belt failure.

V. **Transmission and drive belt relationships**

A. The transmission should deliver maximum power to the track under all conditions and load demands.

B. To transmit power from the engine to the track, the transmission uses a system of clutches (variable ratio pulleys) connected by a drive belt.

INFORMATION SHEET

C. The condition of clutch sheaves can greatly affect drive belt life and performance.

D. Clutch sheaves must always meet manufacturer's specifications for dimensions and construction.

E. Clutch sheaves should be clean, and the drive clutch and driven clutch always aligned with proper offset, center distance, and parallelism.

F. The drive belt performance and life is affected by length, dimensions, construction, cleanliness of the clutch sheaves and alignment of the drive clutch and driven clutch to proper offset, center distance, and parallelism dimensions.

VI. Drive belt alignment

A. If drive clutch and driven clutch are not in alignment, drive belt problems may occur.

B. Improper alignment can cause excessive belt wear and a buildup of belt residue which can cause the belt to squeal, become too hot, or ride the sides of the clutch sheaves.

C. The offset dimension determines the alignment of the drive belt during the various stages of shifting.

  1. Offset is set so that the belt is running nearly straight as the driven clutch and drive clutch revolve at nearly a 1:1 ratio.

  2. Adjustment of the offset is accomplished by moving the driven clutch laterally on the driven shaft or jackshaft.

D. The center distance measurement has a direct relationship to the drive belt length and the effective ratios of the belt during shifting.

  1. Center distance is the distance between the center of the engine crankshaft and the center of the driven shaft, or jackshaft.

  2. Incorrect center distance yields the same results as too long or too short drive belt.

VII. Drive belt manufacturers

A. There are two primary U.S. manufacturers of drive belts and one Japanese manufacturer.

B. Gates Rubber Company supplies a host of drive belts for snowmobiles.

C. Dayco manufactures a wide assortment of drive belts which are used predominantly by the Bombardier Company in production of Ski-Doos.

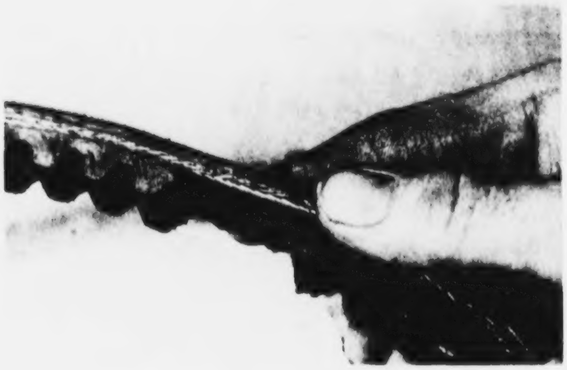
D. The "V-belt" which is used in Yamaha snowmobiles is manufactured in Japan.

INFORMATION SHEET

VIII. Belt failures, causes and corrections (Transparency)

A. Bottom-wear — Sheared or worn cogs (Figure 3)

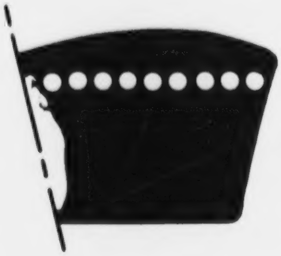
FIGURE 3



1. Bottom wear is caused by a belt that is too short or a clutch center distance that is too great which in turn causes the belt to contact the clutch shaft as the engine idles
2. Bottom wear can be corrected by selecting proper belt size and correcting center distance

B. Severe sidewall wear — Curved or concave belt wear on sidewalls (Figure 4)

FIGURE 4

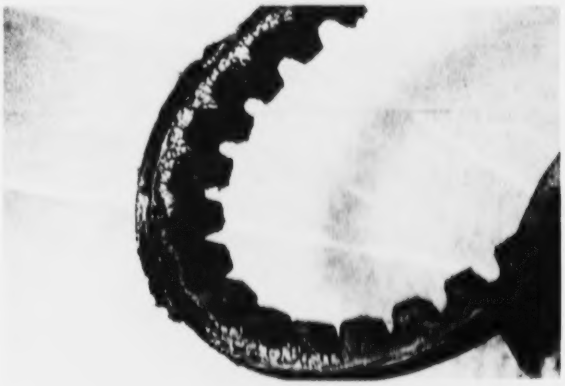


1. Severe sidewall wear is caused by misalignment or improper belt selection
2. Severe sidewall wear can be corrected by replacement with a proper size belt, a check of pulley alignment, and proper tightening of loose engine mounts

INFORMATION SHEET

C. Overheating and glazing — Burned sidewall (Figure 5)

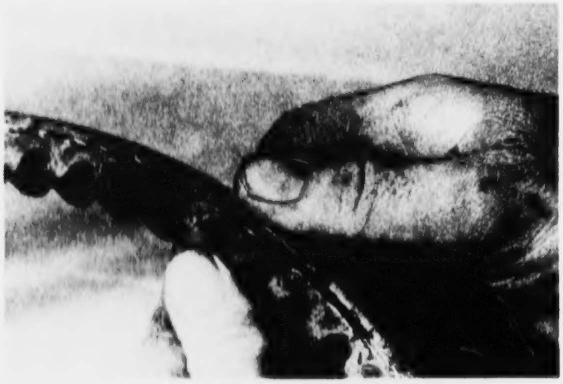
FIGURE 5



1. Glazing is caused by belt slippage because of insufficient pressure on the sides of the belt
2. Glazing can be corrected by making sure the clutches are operating properly, check sheaves for oil or grease

D. Cord separation — Belt cords begin separating from the belt body (Figure 6)

FIGURE 6



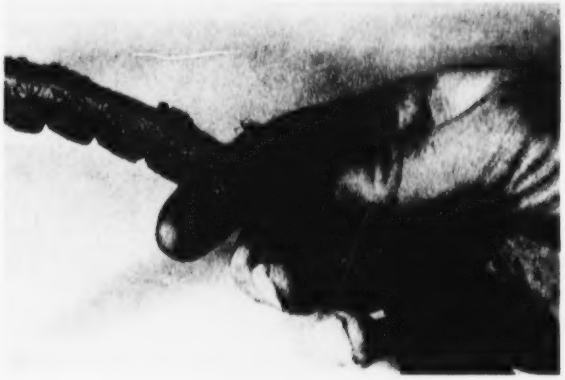
INFORMATION SHEET

1. Cord separation is caused by misalignment and usually begins with severe sidewall wear accompanied by top edge wear

2. Cord separation can be corrected by replacement with a proper belt and proper clutch alignment

E. Blown or broken belt — Belt partially or completely disintegrates (Figure 7)

FIGURE 7



1. A broken or blown belt may be caused by age and use, a frozen track, excessive rpm and torque from using an improper belt on a high performance sled, or any wear conditions coupled with high rpm

2. A broken or blown belt problem can be corrected by assuring free track operation, proper alignment, and the selection of a belt design proper for the sled

DRIVE BELTS
UNIT IV

ASSIGNMENT SHEET #1 — SOLVE PROBLEMS RELATED TO DRIVE BELTS

Directions: Read the following problems carefully and respond as directed.

A. What is the number one cause of drive belt failure?

B. To promote belt life, what precaution should be taken before shifting into high speed operating conditions just after starting a cold machine?

C. What clutch alignment features must be checked to assure proper drive belt life and performance?

D. If a drive belt being removed is also going to be reinstalled, what precaution should be taken?

DRIVE BELTS
UNIT IV

ANSWERS TO ASSIGNMENT SHEET #1

A. Heat

B. Allow the machine to warm up

C. Offset, center distance, and parallelism

D. Mark the direction of belt travel and reinstall the belt so it will travel in the same direction

DRIVE BELTS
UNIT IV

JOB SHEET #1 — REMOVE AND INSTALL A DRIVE BELT

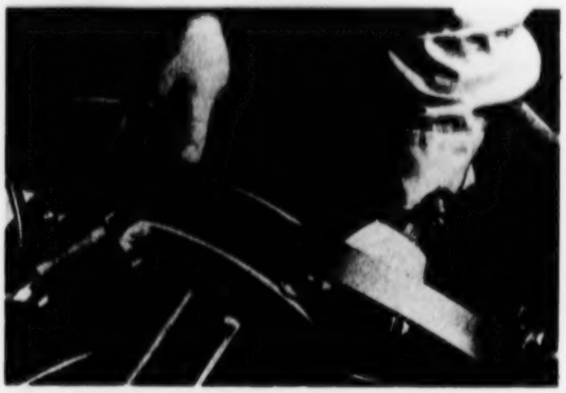
A. Tools and materials

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Basic hand tools
4. Replacement belt as required
5. Safety glasses

B. Procedure

1. Put on safety glasses.
2. Remove shields or guards which enclose the drive clutch or drive assembly.
3. Force the driven clutch open by twisting and pushing the movable sheave with your hand, but do not pry on the belt or you could damage the driven clutch. (Figure 1)

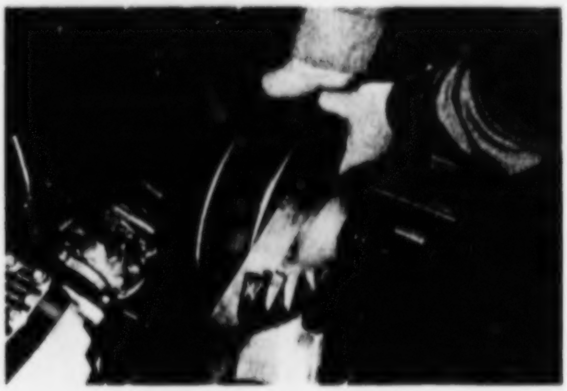
FIGURE 1



JOB SHEET #1

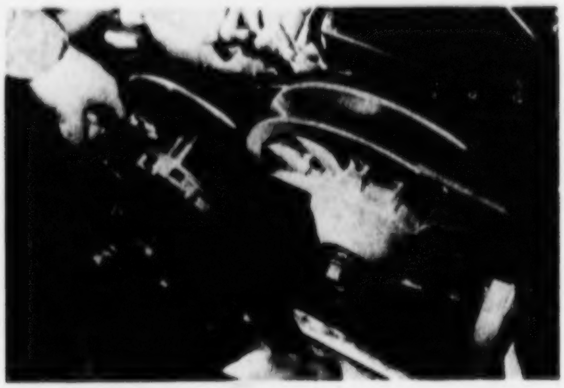
4. Hold the driven clutch open with one hand and use the other hand to slip the slackened belt over the top edge of the movable sheave of the clutch. (Figure 2)

FIGURE 2



5. Slip the drive belt from the driven clutch and slip the other end off the drive clutch. (Figure 3)

FIGURE 3



JOB SHEET #1

6. Install the drive belt by reversing the procedure, make certain that offset, center distance, and parallelism are correct, and if the original belt is used, make sure the direction of travel is the same as when the belt was removed.

7. Reinstall shields or guards properly.

☐ Have your instructor check your work.

8. Test the sled for proper performance.

9. Clean up area and return tools and materials to proper storage.

DRIVE BELTS
UNIT IV

NAME ____________________

TEST

1. Match terms related to drive belts with their correct definitions.

_____a. Rubber and fabric belt used to transfer power from the drive clutch to the driven clutch

_____b. The deterioration of the drive belt to the point where excessive belt speed or dirty sheaves will cause the belt to come apart while the snowmobile is in operation

_____c. Heavy reinforcement material molded into the drive belt to give the belt strength and long life

_____d. Ridge-like indentations on the underside of a belt which allow flexibility in wrapping the belt on the sheaves

_____e. When the belt overrides the clutch sheaves because the belt is too long or the clutches are too close together

_____f. The sides of the drive belt

1. Cogs
2. Sidewalls
3. Belt disintegration
4. Belt ride out
5. Drive belt
6. Cords

2. Complete statements concerning drive belt principles by circling the word(s) or figure(s) that best completes each statement.

   a. Drive belts have (**two, three**) components which affect drive system performance.

      1) The drive belt (**cogs, dimensions**) must be matched to the snowmobile at the factory, both width and circumference.

      2) Drive belt construction influences the way the clutches shift, and the amount of power that will be transmitted through the (**drive, engine**) system.

   b. In addition to the construction of the drive belt, the (**depth, length**) of the belt plays an important part in drive system performance.

   c. A drive belt too long will not have a full shift ratio available to the clutches, and will cause (**poor, rapid**) acceleration and a loss in top speed.

TEST

d. A drive belt too thin will have the same effect as a belt that is too (**long, short**).

e. A drive belt which is too short will influence shift and the amount of power transmitted through the drive system, causing (**different, similar**) shift patterns than specified for the machine.

f. There is no spacific time or (**mileage, place**) at which a drive belt suddenly wears out or fails.

g. With proper maintenance a drive belt can last (**a winter season, half a winter season**).

h. Many manufacturers recommend that drive belts be inspected at least (**twice, three times**) a year.

i. Drive belt improvements through the years have (**helped, not helped**) increase snowmobile performance.

3. Complete statements concerning drive belt installation by circling the word(s) that best completes each statement.

a. When removing a drive belt that will later be reinstalled, mark the direction of travel and reinstall the belt so that it will rotate in (**the same, the opposite**) direction.

b. Never install a drive belt with the (**ignition switch, emergency switch**) on.

c. Keep the motor mounts and the chain case (**loose, rigid**) at all times to insure proper clutch alignment.

d. Never (**work, pry**) a drive belt off or onto a clutch.

e. Always replace the (**belt guard, cowling**) before operating the sled.

4. Match common causes of drive belt failure with ways to avoid them.

_____a. This number one cause of belt failure can be avoided by proper belt selection, proper clutch alignment, and proper operation.

_____b. Since proper alignment is critical to both performance and belt life, inspect for correct offset, center distance, and parallelism when inspecting or installing a belt.

_____c. Belt life is dramatically reduced if the belt is not properly warmed up before shifting into high speed conditions, so run the sled awhile before speed runs.

_____d. Failure to check belt alignment before or after summer storage may also cause belt failure.

1. Cold belt
2. Heat
3. Seasonal oversight
4. Clutch misalignment

TEST

5. Complete statements concerning transmission and drive belt relationships by inserting the word(s) that best completes each statement.

   a. The transmission should deliver maximum power to the ____________ under all conditions and load demands.

   b. To transmit power from the engine to the track, the transmission uses a system of ____________ connected by a drive belt.

   c. The condition of clutch ____________ can greatly affect drive belt life and performance.

   d. Clutch sheaves must always meet manufacturer's specifications for ____________ and construction.

   e. Clutch sheaves should be clean, and the drive clutch and driven clutch always aligned with proper ____________, center distance, and parallelism.

   f. The drive belt performance and life is affected by length, dimensions, construction, ____________ of the clutch sheaves, and alignment of the drive clutch and driven clutch to proper offset, center distance, and parallelism dimensions.

6. Select true statements concerning drive belt alignment by placing an "X" beside each statement that is true.

   (NOTE: For a statement to be true, all parts of the statement must be true.)

   _____a. If drive clutch and driven clutch are not in alignment, drive belt problems may occur.

   _____b. Improper alignment can cause excessive belt wear and a buildup of belt residue which can cause the belt to squeal, become too hot, or ride the sides of the clutch sheaves.

   _____c. The center distance dimension determines the alignment of the drive belt during the various stages of shifting.

      _____1) Offset is set so that the belt is running nearly straight as the driven clutch and drive clutch revolve at nearly a 1:2 ratio.

      _____2) Adjustment of the offset is accomplished by moving the driven clutch laterally on the driven shaft or jackshaft.

   _____d. The center distance measurement has a direct relationship to the drive belt length and the effective ratios of the belt during shifting.

      _____1) Center distance is the distance between the center of the engine crankshaft and the center of the driven shaft, or jackshaft.

      _____2) Incorrect center distance yields the opposite results as too long or too short drive belt.

TEST

7. Select true statements concerning drive belt manufacturers by placing an "X" beside each statement that is true.

_____a. There are three primary U.S. manufacturers of drive belts and one Japanese manufacturer.

_____b. Gates Rubber Company supplies a host of drive belts for snowmobiles.

_____c. Dayco manufactures a wide assortment of drive belts which are used predominantly by the Rupp Company in production of Ski-Doos.

_____d. The "V-belt" which is used in Yamaha snowmobiles is manufactured in Japan.

8. Match belt failures with their causes and corrections.

_____a. 1) Caused by a belt that is too short or a clutch center distance that is too great which in turn causes the belt to contact the clutch shaft as the engine idles

2) Can be corrected by selecting proper belt size and correcting center distance

_____b. 1) Caused by misalignment or improper belt selection

2) Can be corrected by replacement with a proper size belt, a check of pulley alignment, and proper tightening of loose engine mounts

_____c. 1) Caused by belt slippage because of insufficient pressure on the sides of the belt

2) Can be corrected by making sure the clutches are operating properly, check sheaves for oil or grease

_____d. 1) Caused by misalignment and usually begins with severe sidewall wear accompanied by top edge wear

2) Can be corrected by replacement with a proper belt and proper clutch alignment

1. Cord separation — Belt cords begin separating from the belt body
2. Overheating and glazing — Burned sidewall
3. Severe sidewall wear — Curved or concave belt wear on sidewalls
4. Blown or broken belt — Belt partially or completely disintegrates
5. Bottom-wear — Sheared or worn cogs

TEST

_____e. 1) May be caused by age and use, a frozen track, excessive rpm and torque from using an improper belt on a high performance sled, or any wear conditions coupled with high rpm

2) Can be corrected by assuring free track operation, proper alignment, and the selection of a belt design proper for the sled

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

9. Solve problems related to drive belts and transmissions. (Assignment Sheet #1)

10. Demonstrate the ability to remove and install a drive belt. (Job Sheet #1)

DRIVE BELTS
UNIT IV

ANSWERS TO TEST

1. a. 5
   b. 3
   c. 6
   d. 1
   e. 4
   f. 2

2. a. Two
      1) Dimensions
      2) Drive
   b. Length
   c. Poor
   d. Long
   e. Different
   f. Mileage
   g. A winter season
   h. Twice
   i. Helped

3. a. The same
   b. Ignition switch
   c. Rigid
   d. Pry
   e. Belt guard

4. a. 2
   b. 4
   c. 1
   d. 3

5. a. Track
   b. Clutches
   c. Sheaves
   d. Dimensions
   e. Offset
   f. Cleanliness

6. a, b

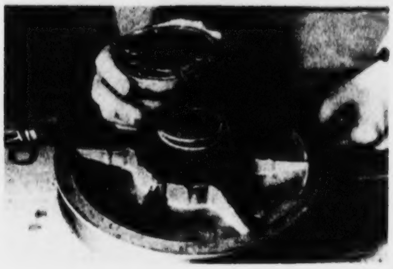
7. b, d

ANSWERS TO TEST

8. a. 5
   b. 3
   c. 2
   d. 1
   e. 4

9. Evaluated to the satisfaction of the instructor

10. Performance skills evaluated according to procedures written in the job sheets



DRIVEN CLUTCH
UNIT V

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify parts of a driven clutch, discuss transmission principles in general, and discuss specifically driven clutch operations. The student should also be able to remove, inspect, and replace a driven clutch and make adjustments for proper offset, parallelism, and center distance in a variable-clutch transmission. These competencies will be evidenced by correctly performing the procedures outlined in the assignment and job sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to the driven clutch with their correct definitions.
2. Identify parts of a driven clutch.
3. Complete statements concerning transmission principles.
4. Complete statements concerning driven clutch principles.
5. Select true statements concerning driven clutch operations.
6. Complete statements concerning clutch types.
7. Select true statements concerning drive clutch/driven clutch relationship.
8. Complete statements concerning adjusting offset.
9. Select true statements concerning adjusting center distance.
10. Complete statements concerning adjusting parallelism.
11. Solve problems related to transmission principles. (Assignment Sheet #1)
12. Demonstrate the ability to:
    a. Disassemble a driven clutch. (Job Sheet #1)
    b. Reassemble a driven clutch. (Job Sheet #2)

DRIVEN CLUTCH
UNIT V

SUGGESTED ACTIVITIES

A. Provide students with objective sheet.

B. Provide students with information sheet.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Demonstrate and discuss the procedures outlined in the job sheets.

G. Have students identify all the components following driven clutch disassembly.

H. Impress upon students the importance of exact measurements in measuring offset, center distance, and parallelism.

I. Give test.

CONTENTS OF THIS UNIT

A. Objective sheet

B. Information sheet

C. Transparency masters

    1. TM 1 — Driven Clutch
    2. TM 2 — Measuring Offset
    3. TM 3 — Measuring Center Distance and Parallelism

D. Assignment Sheet #1 — Solve Problems Related to Transmission Principles

E. Answers to assignment sheet

F. Job sheets

    1. Job Sheet #1 - Remove, inspect, and replace a driven clutch
    2.. Job Sheet #2 - Check and adjust offset, center distance and parallelism on a snowmobile transmission

CONTENTS OF THIS UNIT

G. Test

H. Answers to test

REFERENCES USED IN DEVELOPING THIS UNIT

A. *Snowmobile Repair.* Stillwater, OK, 74074: The Mid-America Vocational Curriculum Consortium. 1976.

B. *Chilton's Snowmobiles Repair & Tune-Up Guide,* Second edition. Radnor, PA: Chilton Book Co., 1975.

C. *Arctic Cat Service Manual No. 2254-302.* Thief River Falls, MN 56701: ARCTCO, Inc., 1984.

D. *1980 Bombardier Snowmobiles Shop Manual.* Valcourt, Quebec, Canada: Bombardier, Ltd., 1980.

E. *Kawasaki Drifter Snowmobile Shop Manual.* Santa Ana, CA 92799-5252: Kawasaki Motors Corp., U.S.A., 1980.

F. *Kawasaki Parts Catalog SB340-A2, SB440-A5.* Santa Ana, CA 92799-5252: Kawasaki Motors Corp., U.S.A., 1980.

DRIVEN CLUTCH
UNIT V

INFORMATION SHEET

I. **Terms and definitions**

   A. Driven clutch — Often referred to as a torque converter; it is mounted to the jackshaft, or sometimes to the chaincase, and transfers power to the track

   B. Torque sensing — A feature of the driven clutch which measures resistance on the track so the correct shift sequence can be determined for engine torque output

   C. Load — Resistance to power

   D. Stationary sheave — The nonmoving part of the driven clutch which contains the shaft and is coupled to the jackshaft or chain case

   E. Movable sheave — The part of the driven clutch which moves back and forth in response to varying loads and rpm's

   F. Downshift — A shift in ratio between the drive clutch and driven clutch to decrease snowmobile speed and increase torque

   G. Driven shaft — Also called the jackshaft on which the driven clutch, brake disc, and upper sprocket are all mounted

   H. Spring — A metal coil preloaded with tension to keep pressure on the drive belt

   I. Variable ratio — The number of revolutions made by the drive clutch compared to the revolutions made by the driven clutch in response to sled load and engine rpm's

   J. Cam torque bracket — Also called a ramp; enables the movable sheave to slide so that the drive belt can move freely up and down the driven clutch in response to vehicle load

II. **Parts of a driven clutch** (Transparency 1)

   A. Retaining ring

   B. Cam torque bracket

   C. Spring

   D. Ramp slide

   E. Movable sheave

INFORMATION SHEET

F. Bushing

G. Stationary sheave

III. **Transmission principles**

A. In snowmobiles, a variable ratio transmission is used to transmit engine power to the track.

B. Engine torque and rpm must be increased because snowmobile engines do not have a wide enough power band to meet a variety of load demands at varying rpm's.

C. The variable ratio transmission in a snowmobile has three primary components:

1. The drive clutch
2. The driven clutch
3. The drive belt

D. The transmission in a snowmobile multiplies engine torque to the track just as a lever with a fulcrum allows small weights to lift large weights.

E. Changing the drive clutch to driven clutch ratio has the same effect as moving the fulcrum on a lever to raise or lower heavy weights.

F. The drive clutch and driven clutch are like gears, but instead of heaving teeth, a drive belt rotates between the sheaves of the two clutches to transmit power.

G. The sheaves of the two clutches are moved laterally to change the effective diameter of the clutch.

H. Snowmobile speed is controlled by the ratio the belt seeks between the drive clutch sheaves and the driven clutch sheaves.

I. The ratio of 3.8:1 (about 20 mph) means that the sheave diameter of the drive clutch must revolve 3.8 times to match one revolution of the driven clutch.

IV. **Driven clutch principles**

A. The driven clutch is load sensing and transfers power to the jackshaft and to the track.

B. The purpose of the driven clutch is to sense the amount of load on the snowmobile and to keep the proper tension on the drive belt.

INFORMATION SHEET

C. The driven clutch senses the amount of resistance from the track, and shifts to the highest possible ratio to attain the maximum speed and power needed to move the snowmobile.

D. When resistance on the driven clutch is great, the driven clutch becomes dominant and overrides the drive clutch by downshifting into a ratio that will supply the torque needed to move the increased load.

E. As downshifting occurs, the engine rpm remains at peak output.

V. **Driven clutch operations**

A. Spring tension and cam angle both affect the shift pattern in the driven clutch.

B. Spring tension determines the rpm of the engine during the shift pattern.

C. Spring tension adjustment matches the sled load to the engine power band

D. Increasing spring tension increases engines rpm, while decreasing the tension decreases engine rpm.

E. Cam angle works in conjunction with spring tension to control the upshift of the driven clutch.

F. On almost all modern snowmobiles, the correct cams are installed at the factory and should not be altered.

VI. **Driven clutch types**

A. Driven clutch types are identified by their location in relation to the chain mechanism which drives the track.

B. The chain case type of driven clutch is mounted to the chain case.

C. The jackshaft type of driven clutch is mounted onto the jackshaft.

D. The drive axle type of driven clutch is mounted onto the drive axle.

E. With most manufacturers, the location of the driven clutch does not alter its purpose, the way it functions, or even the construction of the driven clutch.

VII. **Drive clutch/driven clutch relationship** (Transparency 2)

A. Alignment of the two clutches is essential to maximize the efficient transfer of power from the engine to the track.

B. Improper alignment can cause excessive drive belt residue buildup, excessive belt temperature, belt squeal, or total belt failure.

INFORMATION SHEET

C. Alignment is accomplished by adjusting the offset, parallelism, and center distance measurements.

VIII. **Adjusting offset** (Transparency 2)

A. Offset is measured from the back face of the stationary sheave on the drive clutch to the edge of the movable sheave on the driven clutch.

B. Most manufacturers have an alignment gauge that should be used to assure proper offset adjustment.

C. On some models, offset adjustments are made by loosening engine mounting nuts, sliding the engine back and forth until offset is correct, and then torquing engine mounting nuts to specifications.

D. On other models, offset adjustments are made by adding or removing shims to move the driven clutch in or out on the driven clutch shaft.

E. In all cases, offset adjustments should be made before adjusting center distance or parallelism.

F. Offset measurements should always agree with manufacturer's specifications.

IX. **Adjusting center distance** (Transparency 3)

A. Center distance is sometimes preset during manufacture and cannot be adjusted, and in such cases, no adjustments should be attempted.

B. In cases where center distance cannot be adjusted, check the drive belt to make sure it is the proper belt, or check other components in the transmission for improper adjustment or worn components.

C. In other cases, center distance can be corrected by loosening the chain case mounting nuts and moving the chain case forward or back as required to make the adjustment.

D. In other cases, center distance can sometimes be corrected by loosening the motor mounts and moving the motor forward or back to make the adjustment.

X. **Adjusting parallelism** (Tranparency 3)

A. Checking or adjusting parallelism requires a straightedge or an alignment gauge and calipers.

B. The straight edge must be flush with the stationary sheave of the driven clutch and extend across the stationary sheave of the drive clutch.

INFORMATION SHEET

C. Two measurements must be taken from the back side of the stationary sheave on the drive clutch to the straightedge:

   1. The first measurement should be at a point on the drive clutch sheave closest to the driven clutch.

   2. The second measurement should be at a point on the drive clutch sheave farthest from the driven clutch.

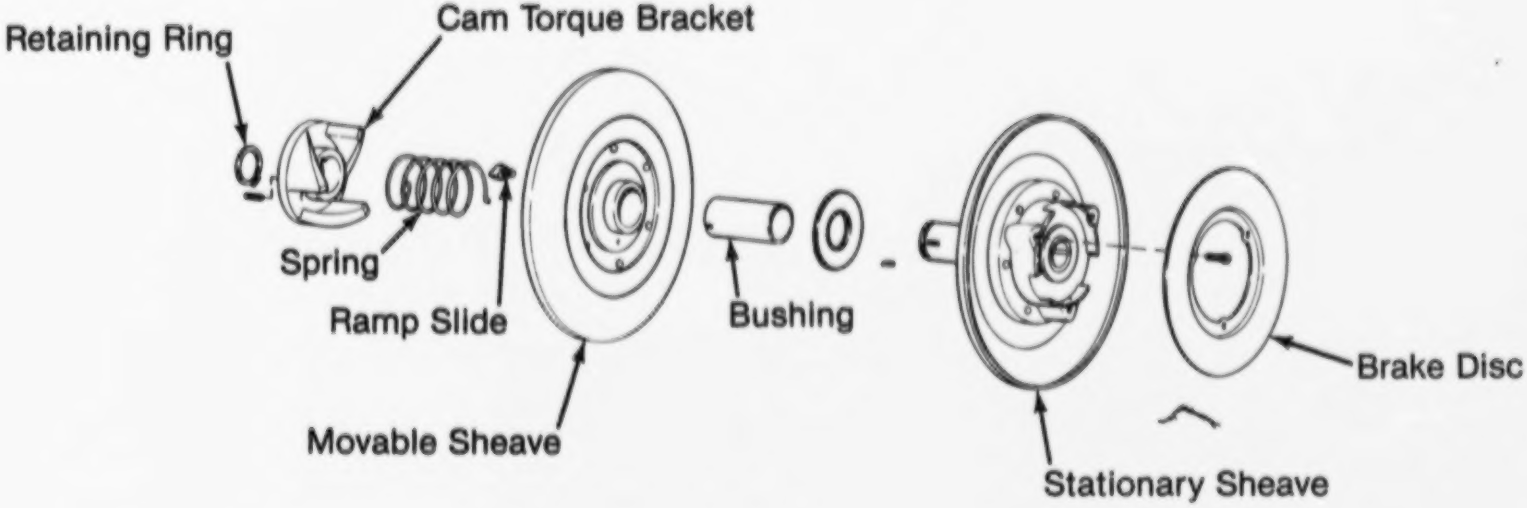
D. The measurement at the second point should be more than the measurement at the first point by about 1.6 mm or $^1/_{16}$th of an inch.

   (NOTE: Always check manufacturer's specifications for the exact distance.)

E. If adjustment is required, loosen the engine mounting nuts and move the engine into a position that will correct the parallelism.

F. When parallelism cannot be corrected by engine mounting adjustment, the adjustment can be completed on some models by installing shims under the chain case mounting nuts.

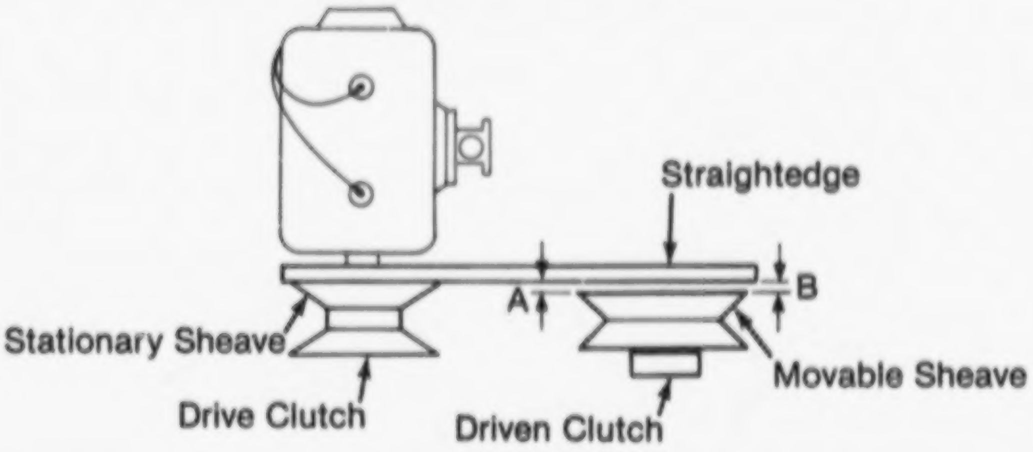
Driven Clutch


Retaining Ring
Cam Torque Bracket
Spring
Ramp Slide
Movable Sheave
Bushing
Stationary Sheave
Brake Disc

Courtesy Kawasaki Motors Corp., U.S.A.

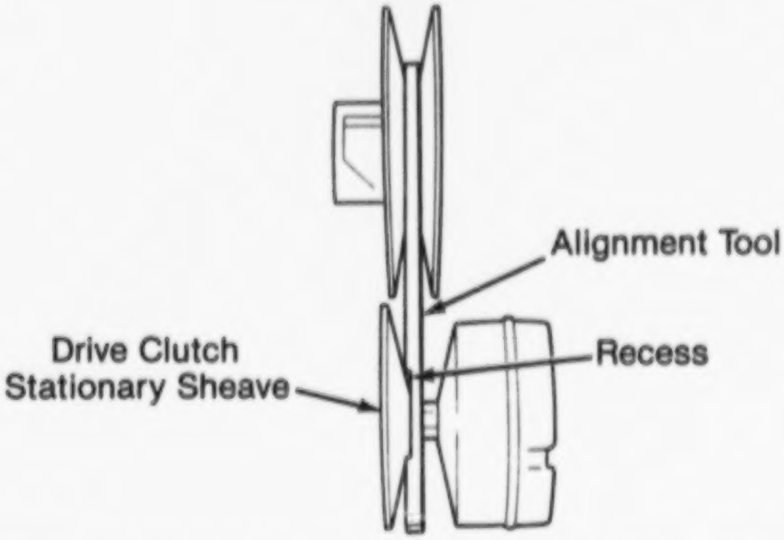
Measuring Offset

With Straightedge


Straightedge
A
B
Stationary Sheave
Movable Sheave
Drive Clutch
Driven Clutch

Distances A and B must be equal and agree with specifications

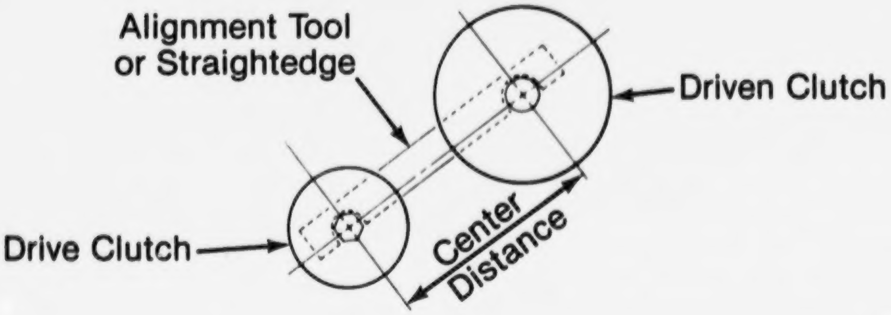
With Alignment Tool

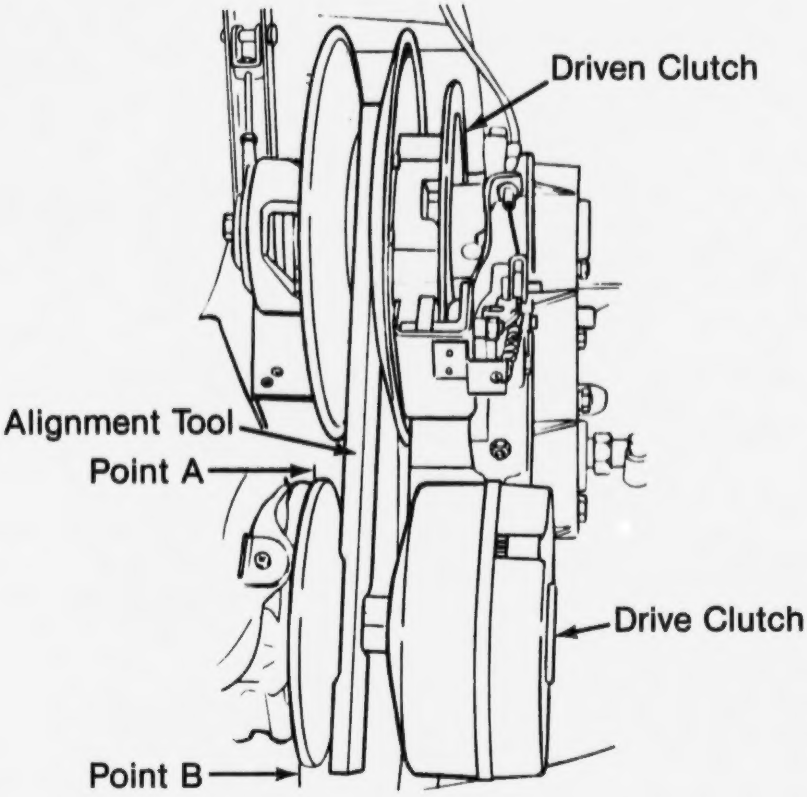

Alignment Tool
Recess
Drive Clutch
Stationary Sheave

Stationary sheave of the drive clutch must fit into the recess of the alignment tool

Courtesy Kawasaki Motors Corp., U.S.A.

Measuring Center Distance and Parallelism


Alignment Tool
or Straightedge
Driven Clutch
Drive Clutch
Center
Distance


Driven Clutch
Alignment Tool
Point A
Drive Clutch
Point B

Courtesy Kawasaki Motors Corp., U.S.A.

DRIVEN CLUTCH
UNIT V

ASSIGNMENT SHEET #1 — SOLVE PROBLEMS RELATED TO TRANSMISSION PRINCIPLES

Directions: Read the following problems carefully and answer as directed.

A. Describe what is meant by a 3.8:1 shift ratio.

B. You have been asked to explain to a friend how the transmission in a snowmobile transmits power from the engine to the track. Explain how the clutch assembly acts to carry heavier loads with the same engine rpm.

C. Explain what can happen to a drive belt if the two clutches are not aligned.

D. Explain why center distance is a measurement which allows only minor alterations.

DRIVEN CLUTCH
UNIT V

ANSWERS TO ASSIGNMENT SHEET

A. A ratio is the relation of the number of revolutions a drive clutch must make to match the diameter and revolutions of the driven clutch. Consequently, the drive clutch must make 3.8 revolutions to match one revolution of the driven clutch.

B. The transmission acts to move power as a lever is used to allow small weights to carry large weights. By changing the fulcrum (pivot point), adjustments can be made for carrying smaller or heavier loads. A snowmobile transmission with a torque sensing driven clutch makes those adjustments automatically.

C. Improper alignment can cause excess drive belt residue buildup, foul the belt, cause excessive heating and belt squeal, and ultimately destroy the belt.

D. Center distance is set at the factory in almost all snowmobiles. Tampering with the settings can alter the center distance and cause misalignment.

DRIVEN CLUTCH
UNIT V

JOB SHEET #1 — REMOVE, INSPECT, AND REPLACE A DRIVEN CLUTCH

A. Tools and materials

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Basic hand tools
4. Solvent
5. Clean shop towels
6. Magic marker
7. Snap-ring pliers
8. Hand-held fish scale
9. High temperature lubricant
10. Feeler gauge
11. Torque wrench
12. Replacement parts as required
13. Safety glasses

B. Routine #1 — Removing the driven clutch

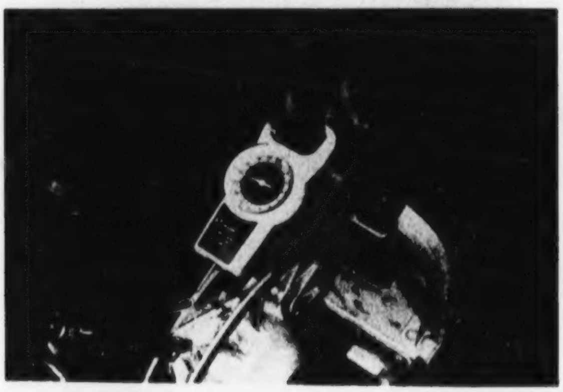
1. Put on safety glasses
2. Remove the clutch guard
3. Place a clean shop towel over the face of the movable sheave, and clamp a pair of locking pliers to the sheave (Figure 1)

JOB SHEET #1

4. Clip a fish scale onto the locking pliers, pull on the scale, and note the amount of spring tension on the driven clutch so you can reset the proper tension when you replace the clutch (Figure 1)

   (NOTE: Tension should be between 12 to 16 pounds.)

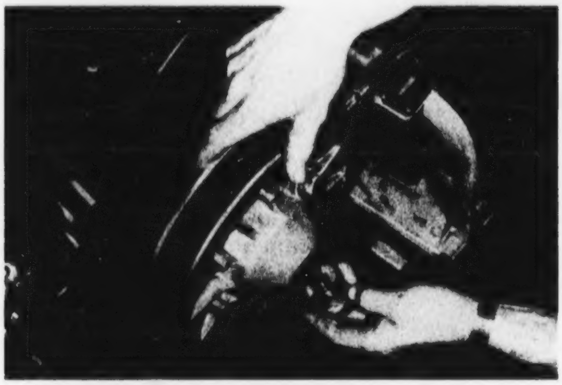
   FIGURE 1



5. Remove the driven clutch from the jackshaft or crankcase (Figure 2)

   (NOTE: On some models, the chain case and driven clutch must be removed as an assembly.)

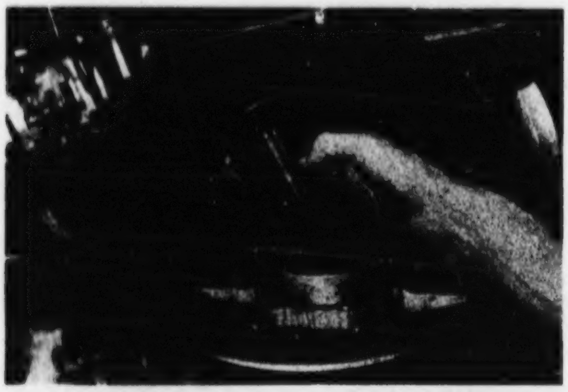
   FIGURE 2



JOB SHEET #1

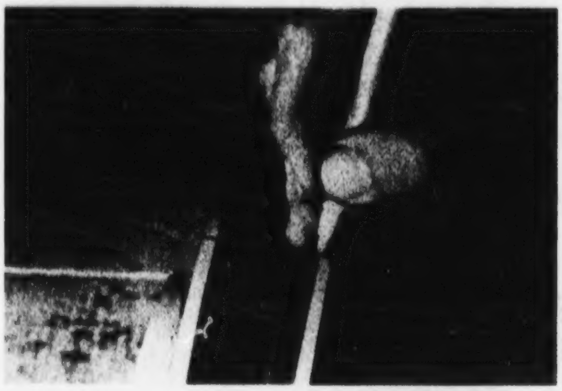
6. Note the position and number of shims, if there are any, and then take the driven clutch to a workbench (Figure 3)

FIGURE 3



7. Mark a line across the edge of the driven clutch sheaves to serve as a first reference mark for properly reassembling the clutch (Figure 4)

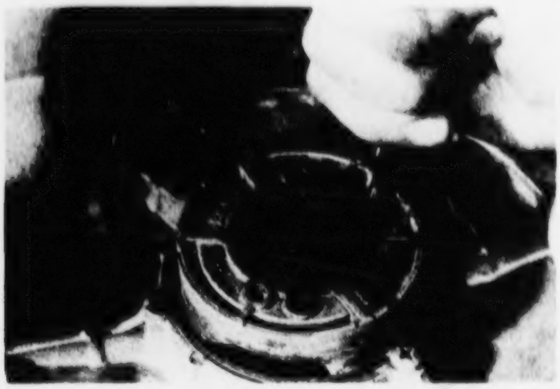
FIGURE 4



JOB SHEET #1

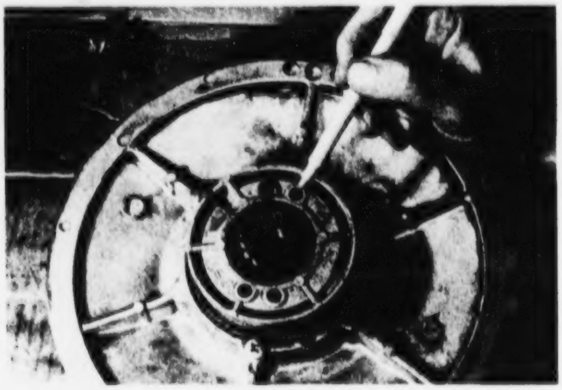
8. Remove the snap ring or cap screws that retain the torque ramp, and be sure to apply downward pressure and permit the spring slowly to unwind (Figure 5)

FIGURE 5



9. Make a note of the hole where the spring is fitted into the torque bracket so you can reassemble the spring with the proper preload (Figure 6)

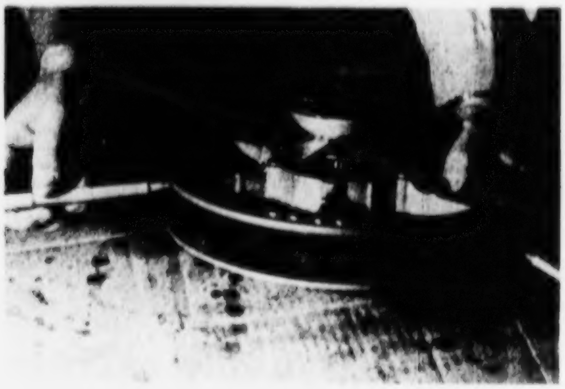
FIGURE 6



JOB SHEET #1

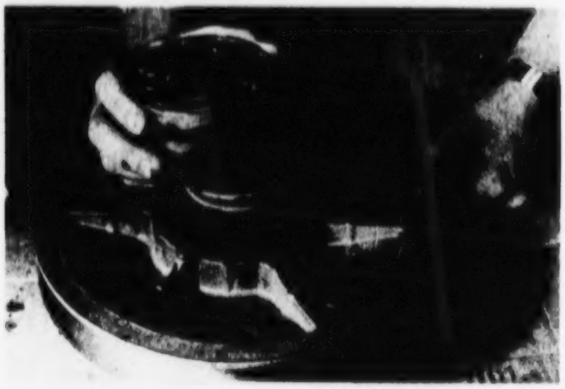
10. Mark a line across the edge of the driven clutch sheaves to serve as a second reference mark for properly reassembling the clutch (Figure 7)

FIGURE 7



11. Remove the torque bracket and spring (Figure 8)

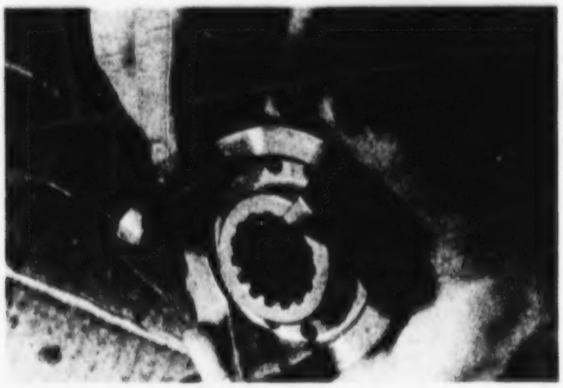
FIGURE 8



JOB SHEET #1

12. Remove the movable sheave from the stationary sheave shaft, and note any shims or washers that may be on the shaft
13. Remove the woodruff key and bushing from the stationary sheave shaft
14. Remove the nylon ramp slides from the face of the movable sheave, if the sheave is so constructed
15. Wash all parts in cleaning solvent and wipe clean and dry with a clean shop towel
16. Inspect the torque ramp surfaces and slides for wear or grooving (Figure 9)

FIGURE 9

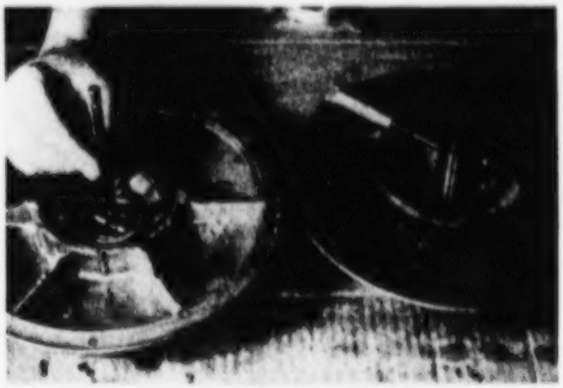


JOB SHEET #1

17. Inspect the main bushing for wear by measuring the inside diameter of the bushing and comparing it with the measurement of the outside diameter of the stationary sheave shaft (Figure 10)

    (NOTE: Wear limits should be listed in the service manual.)

    FIGURE 10



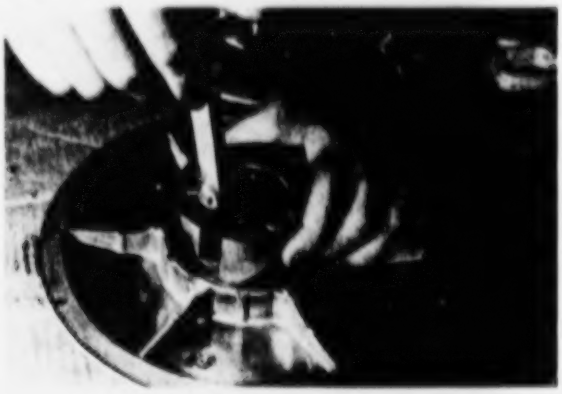
18. Check for wear along the surface where the sheave and torque ramp fit together (Figure 11)

    FIGURE 11

JOB SHEET #1

19. Measure with a feeler gauge to make sure the torque bracket does not have too much play (Figure 12)

FIGURE 12



20. Select replacement parts as required

☐ Have your instructor check your work

C. Routine #2 — Replacing the driven clutch

1. Keep your safety glasses on
2. Check the service manual for lubrication points and the type of lubricant required

   (NOTE: Some clutches require high temperature lubricant and some clutches require no lubricant.)
3. Replace the nylon ramp slide onto the face of the movable sheave, if you removed them
4. Place the bushing and the movable sheave (and shims) onto the shaft, and slip them into position
5. Line the two sheaves up with the second set of index marks
6. Reassemble the clutch spring and torque bracket, and be sure to place the spring in the proper mounting hole noted in Step 9 of Routine #1
7. Turn the entire assembly back so that the two sheaves align with the first index marks

JOB SHEET #1

8. Apply downward pressure on the torque bracket and compress the spring in order to install the snap ring or cap screw

☐ Have your instructor check your work

9. Put shims back in place on the jackshaft to insure proper offset

10. Replace the driven clutch onto the jackshaft or chain case shaft, and torque all mounting nuts to manufacturer's specifications

11. Repeat the fish scale test to make sure the driven clutch has the proper spring tension

☐ Have your instructor check your work

12. Clean up area and return tools and materials to proper storage

DRIVEN CLUTCH
UNIT V

JOB SHEET #2 — CHECK AND ADJUST OFFSET, CENTER DISTANCE, AND PARALLELISM ON A SNOWMOBILE TRANSMISSION

A. Tools and materials

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Basic hand tools
4. Straightedge or alignment tool
5. Steel measuring tape
6. Torque wrench
7. Shims as required
8. Safety glasses

B. Routine #1 — Checking and adjusting offset

(NOTE: Remember that offset adjustments should always be made first before any adjustments to center distance or parallelism.)

1. Put on safety glasses.
2. Remove the clutch guard.

JOB SHEET #2

3. Place a straightedge alongside the two clutches so that one end of the straightedge is flush on the back face of the stationary sheave of the drive clutch and the other edge of the straightedge up along the face of the movable sheave on the driven clutch (Figure 1)

FIGURE 1

4. Measure from the edge of the straightedge to the back edge of the movable sheave on the driven clutch (Figure 2)

FIGURE 2

5. Compare your measurement with the correct offset from manufacturer's specifications in service manual.

JOB SHEET #2

6. Make adjustments to offset according to one of the following procedures:

   a. If the offset is not far enough, remove the driven clutch and add shims to the shaft of the driven clutch until proper offset is attained

   b. If the offset is too much, remove the driven clutch and remove whatever shims are there until proper offset is attained

7. Make the following adjustments to offset only if the procedures in Step 6 failed to attain the proper offset:

   a. Loosen engine mounting bolts that secure the engine mounting plate to the chassis

   b. Slide engine left or right as needed to attain proper offset

   c. Retighten all bolts and torque to manufacturer's specifications.

☐ Have your instructor check your work

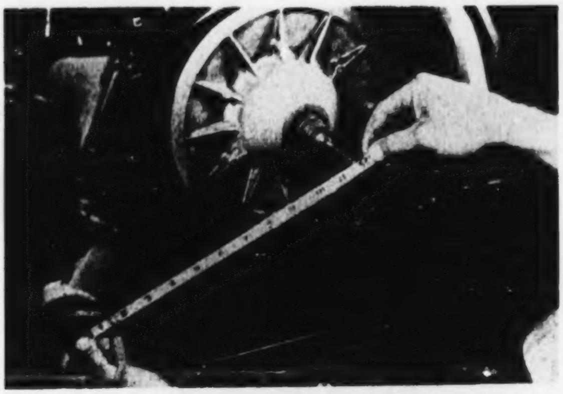
C. Routine #2 — Checking and adjusting center distance

1. Keep your safety glasses on.

2. Measure with a steel rule the distance from the center of the drive clutch shaft to the center of the driven clutch shaft (Figure 3)

   (NOTE: To assure a better measurement, you may want to put an extension from a ratchet set on the nut of the driven clutch so the line of the measurement will be straight.)

   FIGURE 3



JOB SHEET #2

3. Compare measurement with specifications from service manual, and if adjustment is required, make the adjustment according to the following procedure:

   (NOTE: If you're working with a sled that has center distance preset, make no attempt to correct the problem; check with your instructor.)

   a. If the manufacturer recommends, loosen the chain case mounting nuts and move the chain case forward or back as required to adjust center distance

   b. If the manufacturer recommends, loosen the motor mounts and move the motor forward or back to correct center distance

4. Torque all fasteners to specifications

5. Remeasure and check center distance again

☐ Have your instructor check your work

D. Routine #3 — Checking and adjusting parallelism

1. Keep your safety glasses on

2. Place a straightedge flush with the stationary sheave of the driven clutch so that it extends past the stationary sheave of the driven clutch

3. Measure from the straight edge to a point on the drive clutch sheave closest to the driven clutch and record your measurement here ____________; call this point A

4. Measure from the straight edge to a point on the drive clutch sheave farthest from the driven clutch and record your measurement here ____________; call this point B

5. Determine if parallelism needs adjustment according to the following:

   a. If the measurement at B is more than the measurement at A, but does not exceed the A measurement by more than 1.6 mm or 1/16th of an inch, then parallelism is okay

      (NOTE: Check your service manual for the correct distance; the distance given above is typical.)

   b. If the B measurement is less than the A measurement or exceeds the A measurement by more than 1.6 mm or 1/16th of an inch, then parallelism should be corrected

6. Correct parallelism with the following procedure:

   a. Loosen the engine mounting bolts and move the engine into a position that will correct parallelism

JOB SHEET #2

b. If readjusting the engine mounting does not correct parallelism, the adjustment can, perhaps, be completed by installing shims under the chain case mounting nuts

(NOTE: In all cases, follow manufacturer's recommended procedure.)

7. Torque all fasteners to specifications

☐ Have your instructor check your work

8. Replace the chain guard

9. Clean up area and return tools and materials to proper storage

DRIVEN CLUTCH
UNIT V

NAME ______________________

TEST

1. Match terms related to the driven clutch with their correct definitions.

_____a. Often referred to as a torque converter; it is mounted to the jackshaft, or sometimes to the chain case, and transfers power to the track

_____b. A feature of the driven clutch which measures resistance on the track so the correct shift sequence can be determined for engine torque output

_____c. Resistance to power

_____d. The nonmoving part of the driven clutch which contains the shaft and is coupled to the jackshaft or chain case

_____e. The part of the driven clutch which moves back and forth in response to varying loads and rpm's

_____f. A shift in ratio between the drive clutch and driven clutch to decrease snowmobile speed and increase torque

_____g. Also called the jackshaft on which the driven clutch, brake disc, and upper sprocket are all mounted

_____h. A metal coil preloaded with tension to keep pressure on the drive belt

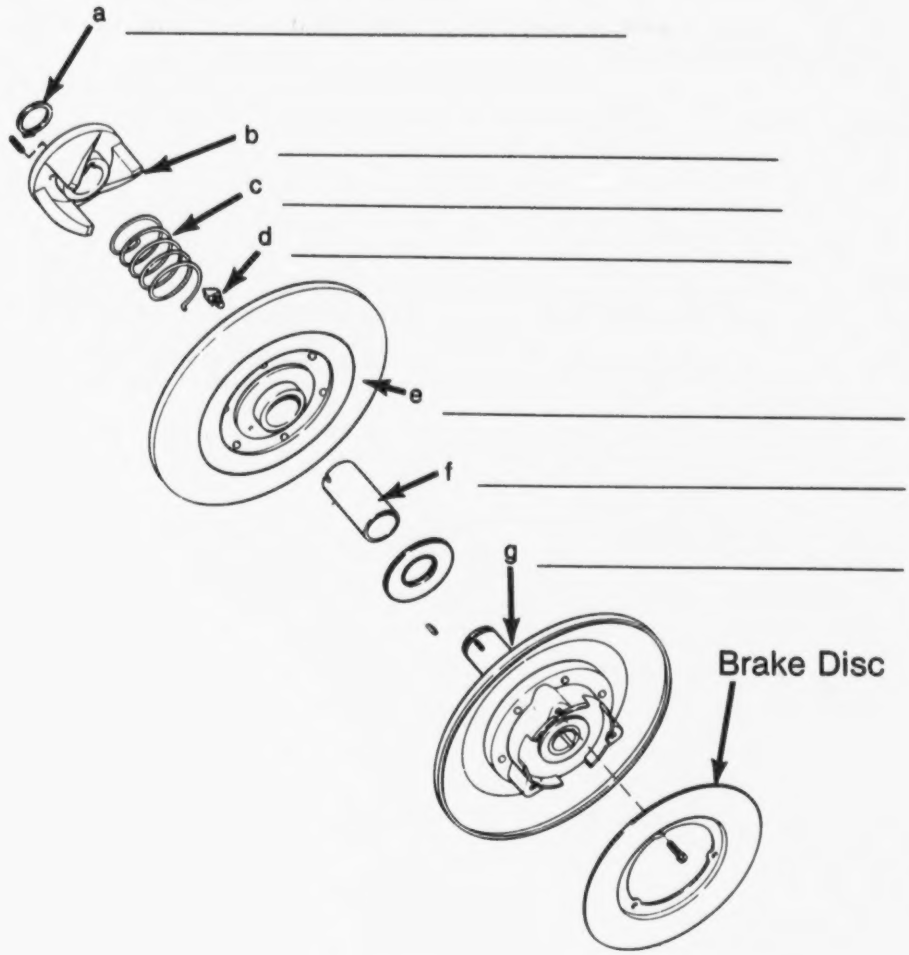
_____i. The number of revolutions made by the drive clutch compared to the revolutions made by the driven clutch in response to sled load and engine rpm's

_____j. Also called a ramp; enables the movable sheave to slide so that the drive belt can move freely up and down the driven clutch in response to vehicle load

1. Cam torque bracket
2. Spring
3. Downshift
4. Stationary sheave
5. Torque sensing
6. Variable ratio
7. Driven shaft
8. Movable sheave
9. Load
10. Driven clutch

TEST

2. Identify parts of a driven clutch by inserting the correct word in the appropriate blank.


a ____________________
b ____________________
c ____________________
d ____________________
e ____________________
f ____________________
g ____________________
Brake Disc

TEST

3. Complete statements concerning transmission principles by circling the word(s) that best completes each statement.

   a. In snowmobiles, a (**static, variable**) ratio transmission is used to transmit engine power to the track.

   b. Engine torque and rpm must be increased because snowmobile engines do not have a (**wide, narrow**) enough power band to meet a variety of load demands at varying rpm's.

   c. The variable ratio transmission in a snowmobile has three primary components:

      1) The drive clutch
      2) The (**driven clutch, jackshaft**)
      3) The drive belt

   d. The transmission in a snowmobile (**divides, multiplies**) engine torque to the track just as a lever with a fulcrum allows small weights to lift large weights.

   e. Changing the drive clutch to driven clutch ratio has (**the same, a different**) effect as moving the fulcrum on a lever to raise or lower heavy weights.

   f. The drive clutch and driven clutch are like gears, but instead of having teeth, a (**chain, drive belt**) rotates between the sheaves of the two clutches to transmit power.

   g. The sheaves of the two clutches are moved laterally to change the effective (**angle, diameter**) of the clutch.

   h. Snowmobile (**direction, speed**) is controlled by the ratio the belt seeks between the drive clutch sheaves and the driven clutch sheaves.

   i. The ratio of 3.8:1 means that the sheave diameter of the drive clutch must revolve 3.8 times to match one revolution of the (**crankshaft, driven clutch**).

4. Complete statements concerning driven clutch principles by inserting the word(s) that best completes each statement.

   a. The driven clutch is load sensing and ____________ power to the jackshaft and to the track.

   b. The purpose of the driven clutch is to ____________ the amount of load on the snowmobile and to keep the proper tension on the drive belt.

   c. The driven clutch senses the amount of ____________ from the track, and shifts to the highest possible ratio to attain the maximum speed and power needed to move the snowmobile.

   d. When resistance on the driven clutch is ____________, the driven clutch becomes dominant and overrides the drive clutch by downshifting into a ratio that will supply the torque needed to move the increased load.

   e. As downshifting occurs the engine rpm remains at ____________ output.

TEST

5. Select true statements concerning driven clutch operations by placing an "X" beside each statement that is true.

_____a. Spring tension and cam angle both affect the shift pattern in the driven clutch.

_____b. Belt tension determines the rpm of the engine during the shift pattern.

_____c. Increasing spring tension decreases engines rpm, while decreasing the tension increases engine rpm.

_____d. Cam angle works in conjunction with spring tension to control the upshift of the driven clutch.

_____e. Spring tension adjustment matches the sled load to the engine power band.

_____f. On almost all modern snowmobiles, the correct cams are installed at the factory and should not be altered.

6. Complete statements concerning driven clutch types by inserting the word(s) that best completes each statement.

a. Driven clutch types are identified by their ____________ in relation to the chain mechanism which drives the track.

b. The chain case type of driven clutch is mounted to the ____________.

c. The jackshaft type of driven clutch is mounted onto the ____________.

d. The drive axle type of driven clutch is mounted onto the ____________.

e. With most manufacturers, the ____________ of the driven clutch does not alter its purpose, the way it functions, or even the construction of the driven clutch.

7. Select true statements concerning the drive clutch/driven clutch relationship by placing an "X" beside each statement that is true.

_____a. Alignment of the two clutches is not essential to maximize the efficient transfer of power from the engine to the track.

_____b. Alignment is accomplished by adjusting the offset, parallelism, and center distance measurements.

_____c. Improper alignment can cause excessive drive belt residue buildup, excessive belt temperature, belt squeal, or total belt failure.

TEST

8. Complete statements concerning adjusting offset by circling the word(s) that best completes each statement.

   a. Offset is measured from the (**front, back**) face of the stationary sheave on the drive clutch to the edge of the movable sheave on the driven clutch.

   b. Most manufacturers have (**an alignment gauge, a straightedge**) that should be used to assure proper offset adjustment.

   c. On some models, offset adjustments are made by (**shimming, loosening**) engine mounting nuts, sliding the engine back and forth until offset is correct, and then torquing engine mounting nuts to specifications.

   d. On other models, offset adjustments are made by adding or removing shims to move the driven clutch (**in or out, up or down**) on the driven clutch shaft.

   e. In all cases, offset adjustments should be made (**after, before**) adjusting center distance or parallelism.

   f. Offset measurements should always (**agree, be approximate**) with manufacturer's specifications.

9. Complete statements concerning adjusting center distance by inserting the word(s) that best completes each statement.

   a. Center distance is sometimes ______________ during manufacture and cannot be adjusted, and in such cases, no adjustments should be attempted.

   b. In cases where center distance cannot be adjusted, check the drive belt to make sure it is the proper belt, or check other components in the transmission for improper ______________ or worn components.

   c. In other cases, center distance can be corrected by loosening the ______________ ______________ mounting nuts and moving the ______________ ______________ forward or back as required to make the adjustment.

   d. In other cases, center distance can sometimes be corrected by loosening the ______________ mounts and moving the ______________ forward or back to make the adjustment.

10. Select true statements concerning adjusting parallelism by placing an "X" beside each statement that is true.

    (NOTE: For a statement to be true, all parts of the statement must be true.)

    ______a. Checking or adjusting parallelism requires a straightedge or an alignment gauge and calipers or a rule.

    ______b. The straight edge must be flush with the stationary sheave of the driven clutch and extend across the stationary sheave of the drive clutch.

TEST

_____c. Two measurements must be taken from the back side of the stationary sheave on the drive clutch to the straightedge:

1) The first measurement should be at a point on the drive clutch sheave closest to the driven clutch.

2) The second measurement should be at a point on the drive clutch sheave farthest from the driven clutch.

_____d. The measurement at the second point should be more than the measurement at the first point by about 1.6 mm or $^1/_{16}$th of an inch.

_____e. If adjustment is required, loosen the engine mounting nuts and move the engine into a position that will correct the parallelism.

_____f. When parallelism cannot be corrected by engine mounting adjustment, the adjustment can be completed on some models by installing shims under the chain case mounting nuts.

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

11. Solve problems related to transmission principles. (Assignment Sheet #1)

12. Demonstrate the ability to:

    a. Remove, inspect, and replace a driven clutch. (Job Sheet #1)

    b. Check and adjust offset, center distance, and parallelism on a snowmobile transmission. (Job Sheet #2)

DRIVEN CLUTCH
UNIT V

ANSWERS TO TEST

1. a. 10
   b. 5
   c. 9
   d. 4
   e. 8
   f. 3
   g. 7
   h. 2
   i. 6
   j. 1

2. a. Retaining ring
   b. Cam torque bracket
   c. Spring
   d. Ramp slide
   e. Movable sheave
   f. Bushing
   g. Stationary sheave

3. a. Variable
   b. Wide
   c. Driven clutch
   d. Multiplies
   e. The same
   f. Drive belt
   g. Diameter
   h. Speed
   i. Driven clutch

4. a. Transfers
   b. Sense
   c. Resistance
   d. Great
   e. Peak

5. a, d, e, f

6. a. Location
   b. Chain case
   c. Jackshaft
   d. Drive axle
   e. Location

7. b, c

8. a. Back
   b. An alignment gauge
   c. Loosening
   d. In or out
   e. Before
   f. Agree

ANSWERS TO TEST

9. a. Preset
   b. Adjustment
   c. Chain case, chain case
   d. Motor, motor

10. a, b, c, d, e, f

11. Evaluated to the satisfaction of the instructor

12. Performance skills evaluated according to procedures written in the job sheets

CHAIN DRIVES
UNIT VI

UNIT OBJECTIVE

After completion of this unit, the student should be able to discuss the chain drive system and list common maintenance procedures and causes of chain problems. The student should also be able to disassemble and reassemble a chain case assembly, and remove, repair, and install a drive chain. These competencies will be evidenced by correctly performing the procedures outlined in the assignment and job sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to chain drives with their correct definitions.
2. Identify parts of a chain case.
3. Complete statements concerning silent chains.
4. Select true statements concerning detachable drive chains.
5. Complete statements concerning causes of chain failure.
6. Select true statements concerning chain drive troubleshooting.
7. Solve problems related to chain drives. (Assignment Sheet #1)
8. Demonstrate the ability to:
   a. Remove, inspect, and replace a chain drive. (Job Sheet #1)
   b. Repair a detachable chain. (Job Sheet #2)

CHAIN DRIVES
UNIT VI

SUGGESTED ACTIVITIES

A. Provide students with objective sheet.

B. Provide students with information sheet.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Demonstrate and discuss the procedures outlined in the job sheets.

G. Invite a local snowmobile repairman to discuss the different types of chains, comparing and contrasting each type, and advantages and disadvantages of each type.

H. Give test.

CONTENTS OF THIS UNIT

A. Objective sheet

B. Information sheet

C. Transparency masters

   1. TM 1 — Parts of a Chain Case Assembly

   2. TM 2 — Detachable Chain

D. Assignment Sheet #1 — Solve Problems Related to Chain Drives

E. Answers to assignment sheet

F. Job sheets

   1. Job Sheet #1 — Remove, Inspect, and Replace a Chain Drive

   2. Job Sheet #2 — Repair a Detachable Chain

G. Test

H. Answers to test

REFERENCES USED IN DEVELOPING THIS UNIT

A. *Snowmobile Repair.* Stillwater, OK 74074: Mid-America Vocational Curriculum Consortium, 1976.

B. *1980 Bombardier Snowmobiles Shop Manual.* Valcourt, Quebec, Canada: Bombardier, Ltd., 1980.

C. *Master Service Training Manual.* Thief River Falls, MN 56701: Arctic Cat, Inc., 1986.

D. *Kawasaki Drifter Snowmobile Shop Manual.* Santa Ana, CA 92799-5252: Kawasaki Motors Corp, U.S.A., 1980.

E. *Kawasaki Parts Catalog SB340-A2, SB440-A5.* Santa Ana, CA 92799-5252: Kawasaki Motors Corp., U.S.A., 1980.

CHAIN DRIVES
UNIT VI

INFORMATION SHEET

I. **Terms and definitions**

A. Drive chain — The chain which links the driven clutch shaft with the drive axle, and is used to transfer the engine power from the driven clutch assembly to the drive axle and track

B. Chain case — A steel or aluminum molded case in which oil is held to lubricate the drive chain and the bearings which support the driven clutch assembly and drive axle

C. Chain tensioner — Automatic or manually adjusted device used to maintain a specified tension on the drive chain

D. Sprocket — A round wheel with plastic or metal teeth that is attached to the driven clutch shaft and drive axle on which the drive chain connects; is used to turn the drive chain and track

E. Oil seals — Used to prevent oil leaking from the chain case where the drive axle and driven clutch shaft enter

F. Plug — Used to check for proper oil level within the chain case or is removed to drain oil

G. Master link — Used to connect a detachable chain together

H. Endless chain — Chain having no master link

I. Detachable chain — Chain that has a master link

J. Silent chain — A chain like the timing-gear chain on an automobile, and the most commonly used chain on modern snowmobiles

II. **Parts of a chain case** (Transparency 1)

A. Drive clutch shaft

B. Chain case

C. Upper sprocket

D. Chain tensioner assembly

E. Chain tensioner spring

F. Chain

INFORMATION SHEET

G. Lower sprocket

H. Drive axle

III. **Silent chains** (Figure 1)

A. Silent chains are endless chains and are the most frequently used chains on snowmobiles

B. As the name implies, silent chains are popular because they run quieter and generally have a longer service life

C. Silent chains are rated by pitch, the distance between adjacent links on a chain, and must be replaced by the correct pitch number or they will not fit the sprockets properly

D. Silent chains usually have to be removed with their sprockets as a single assembly (Figure 1)

FIGURE 1

IV. **Detachable drive chains** (Transparency 1)

A. Detachable drive chains will be found on some older model snowmobiles, but they have generally been replaced with silent chains

B. Detachable chains are held together with master links that are secured by clips and cotter pins

C. When a master link is used, the opening of the securing clip must face in the opposite direction of chain rotation

INFORMATION SHEET

D. Half links were once used with detachable chains, but they are no longer used with snowmobile drive chains

V. **Causes of chain failure**

A. Failure to keep chain well lubricated

B. Improper tension applied to the chain

C. Worn bearings within the chain case

D. Rapid acceleration; fast starts

E. Locking the track

VI. **Chain drive troubleshooting** (Transparency 6)

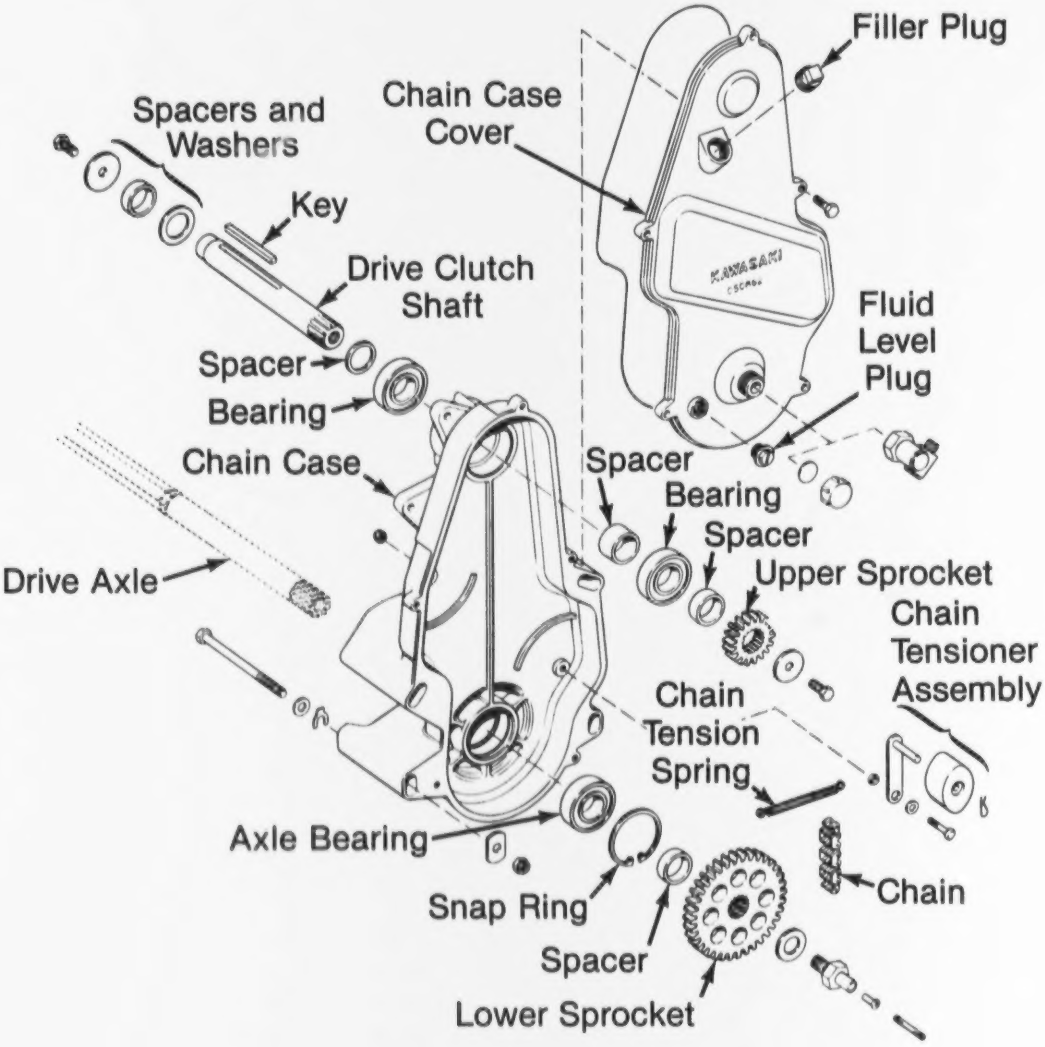
A. Modern snowmobiles rarely need repairs to the chain drive and chain case assembly.

B. Chain repair or replacement is most often needed when owners do not inspect the chain case regularly to insure there is sufficient oil in the oil pan.

C. Owners should inspect the chain case for oil leakage and other problems once a month.

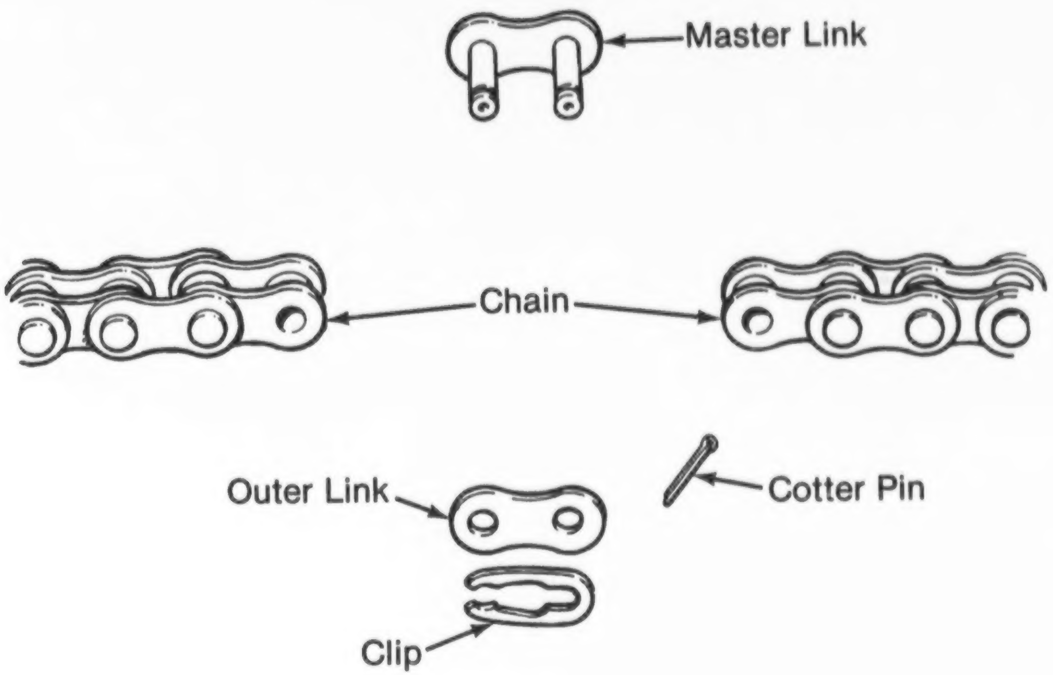
D. Manufacturers suggest that the oil in the chain case be changed each season.

Parts of a Chain Case Assembly


Filler Plug
Spacers and Washers
Chain Case Cover
Key
Drive Clutch Shaft
Fluid Level Plug
Spacer
Bearing
Chain Case
Spacer
Bearing
Spacer
Drive Axle
Upper Sprocket
Chain Tensioner Assembly
Chain Tension Spring
Axle Bearing
Chain
Snap Ring
Spacer
Lower Sprocket
KAWASAKI

Courtesy Kawasaki Motors Corp., U.S.A.

Detachable Chain


Master Link
Chain
Outer Link
Cotter Pin
Clip

CHAIN DRIVES
UNIT VI

ASSIGNMENT SHEET #1 — SOLVE PROBLEMS RELATED TO CHAIN DRIVE

Directions: Read the following problems carefully and respond as directed.

A. Chain drive assemblies rarely require repairs. Describe the routine maintenance to chain drive assemblies which helps prevent problems.

____

____

____

B. What impact does the way the operator uses the snowmobile have on the chain drive?

____

____

____

CHAIN DRIVES
UNIT VI

ANSWERS TO ASSIGNMENT SHEET

A. The most critical items is assuring that the chain and bearings are properly lubricated. So, make sure there is always sufficient oil in the chain case, make sure there are no leaks from the chain case assembly, and change the oil in the case once each season. Also, check chain tension.

B. Rapid acceleration from too fast starts can wear the bearings down faster. Also, locking the track creates unnecessary tension on the chain and links.

CHAIN DRIVES
UNIT VI

JOB SHEET #1 — REMOVE, INSPECT, AND REPLACE A CHAIN DRIVE

A. Tools and materials

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Basic hand tools
4. Empty container for oil
5. Clean shop towels
6. Solvent
7. Replacement chain and/or sprockets as required
8. Torque wrench
9. Safety glasses

B. Routine #1 — Removing the chain drive

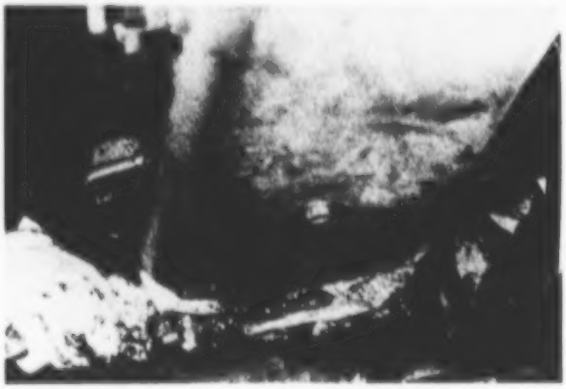
1. Put on safety glasses
2. Remove the chain case guard, if required

JOB SHEET #1

3. Unscrew the chain case oil plug and allow the oil to drain into an empty container, and if it is a model where the oil drains directly onto the under covering of the sled, fill the area with shop towels to absorb the oil (Figure 1)

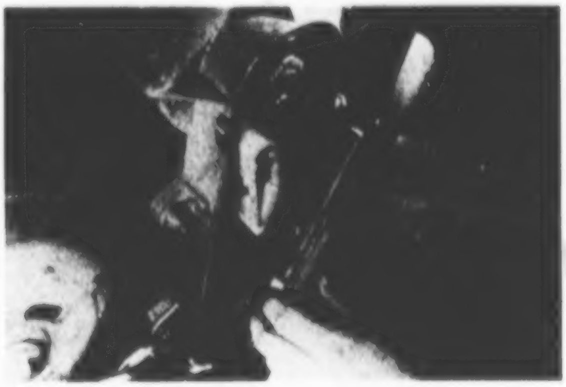
   (NOTE: It's a good idea to replace and tighten the oil drain plug right now so you won't accidentally start refilling the chain case with oil with the plug out.)

   FIGURE 1



4. Unscrew the nuts that secure the chain case cover, and then remove the cover (Figure 2)

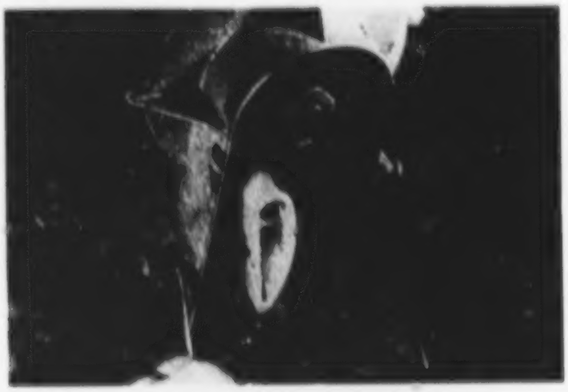
   FIGURE 2



JOB SHEET #1

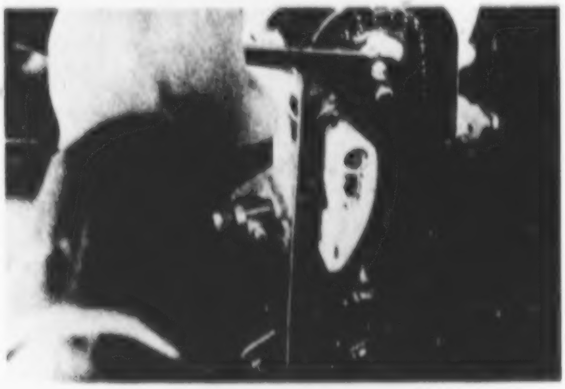
5. Loosen the chain tensioner assembly to the point where the chain can be easily moved (Figure 3)

FIGURE 3



6. Remove the cap screws that secure the upper and lower sprockets to their shafts (Figure 4)

FIGURE 4



7. Remove any bolts, nuts, or cotter pins that secure the sprockets

JOB SHEET #1

8. Remove both sprockets and chain as one assembly and take them to a workbench for cleaning and inspection (Figure 5)

FIGURE 5

☐ Have your instructor check your work

C. Routine #2 — Inspecting the drive chain and sprockets

1. Leave your safety glasses on
2. Clean the chain and sprockets with solvent and wipe dry with a clean shop towel
3. Inspect the teeth in both upper and lower sprockets for cracks, breaks, or excessive wear
4. Work the chain tightly around either one of the sprockets (Figure 6)

FIGURE 6

JOB SHEET #1

5. Use your thumb and forefinger to pull on the chain with moderate pressure, and if half of any sprocket tooth can be uncovered, both the chain and the sprocket should be replaced

6. Repeat the chain/sprocket test for the other sprocket

☐ Have your instructor check your work, and arrange for a replacement chain or sprocket(s) as needed

D. Routine #3 — Replacing the drive chain and sprockets

1. Leave your safety glasses on

2. Replace the chain and sprockets as an assembly and secure the sprockets in place

3. Adjust the chain tension

4. Replace the chain case cover

5. Check the chain case oil plug to make sure it is tight

6. Fill the chain case with new oil as specified by the manufacturer

7. Replace the chain case guard

☐ Have your instructor check your work

8. Clean up area and return tools and materials to proper storage

CHAIN DRIVES
UNIT VI

JOB SHEET #2 — REPAIR A DETACHABLE CHAIN

A. Tools and materials

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Basic hand tools
4. Master link and outer link
5. Clip and cotter pin
6. Pin punch
7. Ball peen hammer
8. Bench grinder
9. Safety glasses

B. Procedure

1. Put on safety glasses
2. Remove the drive chain from the snowmobile as outlined in Job Sheet #1, this unit
3. Clean all broken chain parts, chips, and metal shavings from the chain case
4. Locate the master link to make sure you are working with a detachable chain
5. Determine the number of damaged links that will have to be replaced
6. Make sure that the chain is worth repairing, and if the chain is worn excessively in places other than where it broke, the chain should be replaced
7. Grind off what is left of parts of the link(s) that broke
8. Replace with as many full links as needed
9. Rivet all link pins with a ball peen hammer

   (NOTE: The circlips should face the outer side of the chain case.)

JOB SHEET #2

10. Install the master link with the clip opening facing the opposite direction the chain rotates

☐ Have your instructor check your work

11. Reinstall the chain, sprockets, and chain case assembly as outlined in Job Sheet #1

12. Clean up area and return tools and materials to proper storage

CHAIN DRIVES
UNIT VI

NAME ________________________

TEST

1. Match terms related to chain drives with their correct definitions.

______a. The chain which links the driven clutch shaft with the drive axle, and is used to transfer the engine power from the driven clutch assembly to the drive axle and track

______b. A steel or aluminum molded case in which oil is held to lubricate the drive chain and the bearings which support the driven clutch assembly and drive axle

______c. Automatic or manually adjusted device used to maintain a specified tension on the drive chain

______d. A round wheel with plastic or metal teeth that is attached to the driven clutch shaft and drive axle on which the drive chain connects; it is used to turn the drive chain and track

______e. Used to prevent oil leaking from the chain case where the drive axle and driven clutch shaft enter

______f. Used to check for proper oil level within the chain case or is removed to drain oil

______g. Used to connect a detachable chain together

______h. Chain having no master link

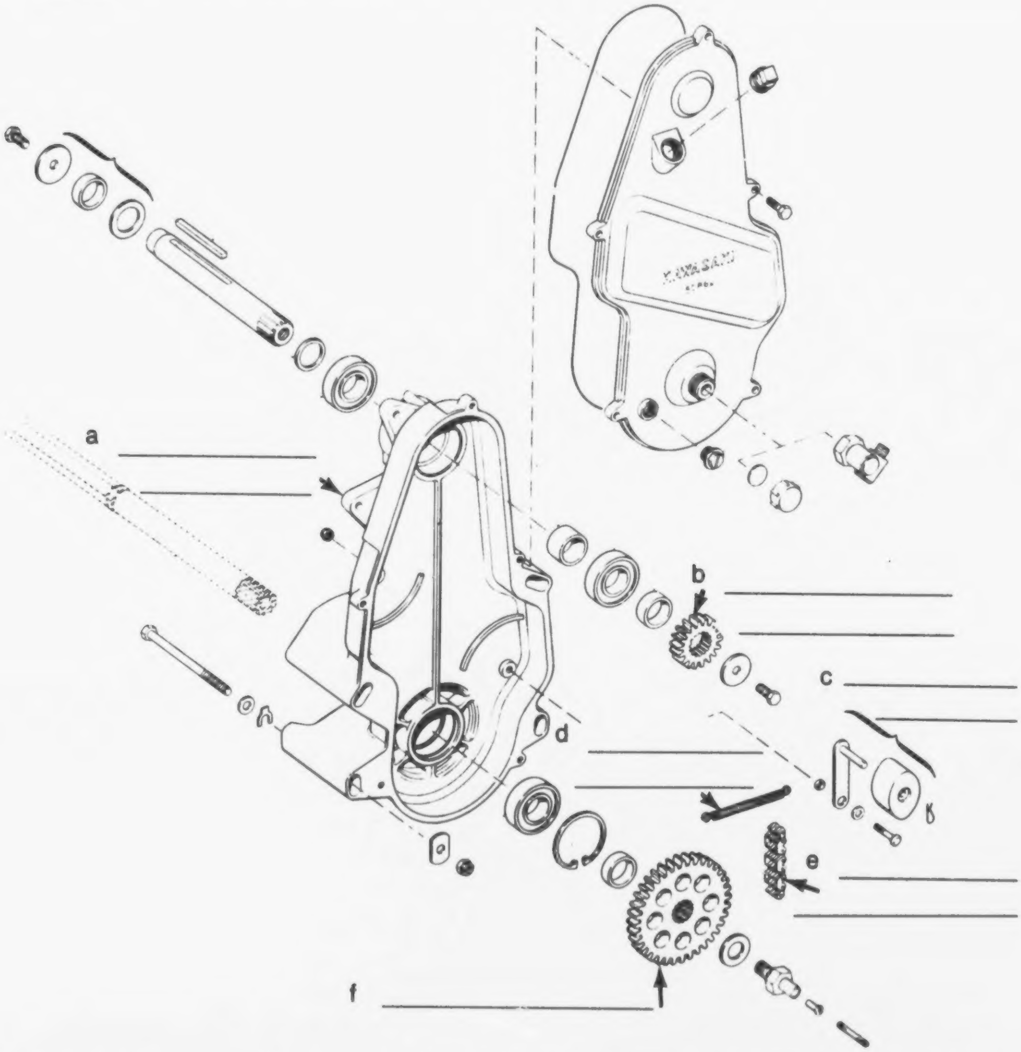
______i. Chain that has a master link

______j. A chain like the timing-gear chain on an automobile and the most commonly used chain on modern snowmobiles

1. Oil seals
2. Sprocket
3. Detachable chain
4. Drive chain
5. Endless chain
6. Silent chain
7. Chain case
8. Plug
9. Chain tensioner
10. Master link

TEST

2. Identify parts of a chain case by inserting the correct part name in the appropriate blank.



3. Complete statements concerning silent chains by inserting the word(s) that best completes each statement.

   a. Silent chains and ____________ chains are the most frequently used chains on snowmobiles.

   b. As the name implies, silent chains are popular because they run ____________ and generally have a longer service life

TEST

c. Silent chains are rated by ____________, the distance between adjacent links on a chain, and must be replaced by the correct ____________ number or they will not fit the sprockets properly

d. Silent chains usually have to be removed with their ____________ as a single assembly

4. Select true statements concerning detachable drive chains by placing an "X" beside each statement that is true.

_____a. Detachable drive chains will be found on some older model snowmobiles, but they have generally been replaced with silent chains.

_____b. Detachable chains are held together with master links that are secured by clips and cotter pins

_____c. When a master link is used, the opening of the securing clip must face in the opposite direction of chain rotation.

_____d. Half links are half as long as master links and used often to adjust chains that are slightly too long or too short.

5. Complete statements concerning causes of chain failure by inserting the word(s) that best completes each statement.

a. Failure to keep chain well ____________

b. Improper ____________ applied to the chain

c. Worn ____________ within the chain case

d. Rapid acceleration; ____________ starts

e. Locking the ____________

6. Select true statements concerning chain drive troubleshooting by placing an "X" beside each statement that is true.

_____a. Modern snowmobiles rarely need repairs to the chain drive and chain case assembly

_____b. Chain repair or replacement is most often needed when owners do not inspect the chain case regularly to insure there is sufficient oil in the oil pan.

_____c. Owners should inspect the chain case for oil leakage and other problems once a year.

_____d. Manufacturers suggest that the oil in the chain case be changed each season.

TEST

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

7. Solve problems related to chain drives. (Assignment Sheet #1)

8. Demonstrate the ability to:

   a. Remove, inspect, and replace a chain drive. (Job Sheet #1)

   b. Repair a detachable chain. (Job Sheet #2)

CHAIN DRIVES
UNIT VI

ANSWERS TO TEST

1. a. 4
   b. 7
   c. 9
   d. 2
   e. 1
   f. 8
   g. 10
   h. 5
   i. 3
   j. 6

2. a. Chain case
   b. Upper sprocket
   c. Chain tensioner assembly
   d. Chain tensioner spring
   e. Chain
   f. Lower sprocket

3. a. Endless
   b. Quieter
   c. Pitch, pitch
   d. Sprockets

4. a, b, c

5. a. Lubricated
   b. Tension
   c. Bearings
   d. Fast
   e. Track

6. a, b, d

7. Evaluated to the satisfaction of the instructor

8. Performance skills evaluated according to procedures written in the job sheets

JACKSHAFTS AND AXLES
UNIT VII

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify components of a drive axle and discuss the basic functions of axles and jackshafts. The student should also be able to remove and install a jackshaft and disassemble and reassemble a drive axle assembly. These competencies will be evidenced by correctly performing the procedures outlined in the assignment and job sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to jackshafts and axles with their correct definitions.
2. Identify components of a drive axle assembly.
3. Complete statements concerning types of axles.
4. Select true statements concerning axle repair.
5. Solve problems related to axle repair and maintenance. (Assignment Sheet #1)
6. Demonstrate the ability to:
    a. Remove and install a jackshaft. (Job Sheet #1)
    b. Disassemble a drive axle assembly. (Job Sheet #2)
    c. Reassemble a drive axle assembly. (Job Sheet #3)

JACKSHAFTS AND AXLES
UNIT VII

SUGGESTED ACTIVITIES

A. Provide students with objective sheet.

B. Provide students with information sheet.

C. Make transparency.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Demonstrate and discuss the procedures outlined in the job sheets.

G. Examine a jackshaft and explain its function and advantages to the class.

H. Give test.

CONTENTS OF THIS UNIT

A. Objective sheet

B. Information sheet

C. Transparency Master 1 — Parts of a Drive Axle

D. Assignment Sheet #1 — Solve Problems Related to Axle Repair and Maintenance

E. Answers to assignment sheet

F. Job sheets

  1. Job Sheet #1 — Remove and Install a Jackshaft

  2. Job Sheet #2 — Disassemble a Drive Axle Assembly

  3. Job Sheet #3 — Reassemble a Drive Axle Assembly

G. Test

H. Answers to test

REFERENCES USED IN DEVELOPING THIS UNIT

A. *Snowmobile Repair.* Stillwater, OK 74074: Mid-America Vocational Curriculum Consortium, 1976.

REFERENCES USED IN DEVELOPING THIS UNIT

B. *1980 Bombardier Snowmobiles Shop Manual.* Valcourt, Quebec, Canada: Bombardier, Ltd., 1975.

C. *1978 Polaris Shop Manual.* Roseau, MN: Polaris/Textron, 1978.

D. *Kawasaki Drifter Snowmobile Shop Manual.* Santa Ana, CA 92799-5252: Kawasaki Motors Corp., U.S.A., 1980.

E. *Kawasaki Parts Catalog SB340-A2, SB440-A5.* Santa Ana, CA 92799-5252: Kawasaki Motors Corp., U.S.A., 1980.

JACKSHAFTS AND AXLES
UNIT VII

INFORMATION SHEET

I. **Terms and definitions**

A. **Drive axle - A solid or semi-solid shaft of steel which connects to the drive chain by a sprocket and drives the track.**

B. Jackshaft — A shaft which extends across the chassis from the driven clutch and down to the chain case serving to transfer power from one side of the snowmobile to the other; found on most high performance models

C. Drive sprockets — Large wheels connected to the drive axle used to turn the track; virtually all snowmobiles use internal drive sprockets

D. Teeth — The portion of the drive sprocket that inserts into or receives a raised portion of track to turn the track

E. Seal — Rubber washer used to seal the chain case where the drive axle or jackshaft enters into the case; used to eliminate oil leakage

F. Flange — A plate used to secure the drive sprockets to the drive axle

G. Rear axle — The rear shaft with sprockets to allow the track to rotate on the snowmobile

II. **Major components of a drive axle assembly** (Transparency 1)

A. Axle

B. Bearing(s)

C. Bearing housing

D. Retaining collar

E. Seal (O-ring)

F. Sprocket(s)

G. Spacer

H. Washers

INFORMATION SHEET

III. **Types of axles**

A. A jackshaft is driven by the driven clutch and transfers power across the snowmobile chassis to the chain case while facilitating a lower profile for the machine

(NOTE: The brake disc is usually mounted on the jackshaft.)

B. A drive axle accepts power from the chain drive and transfers it by sprocket to the track.

C. The rear axle is an idling axle at the rear of the snowmobile where it supports the track as it moves around the rear end of the chassis.

IV. **Axle repair**

A. Little maintenance is required of the axles except to see that bearings on the axles are properly lubricated and that the jack shaft is properly aligned. (See Unit V, Job sheet #2, Routine #2 and #3- Checking and adjusting center distance and parallelism).

B. Most drive axle bearing on the chain case side are lubricated by the chain case lubricant.

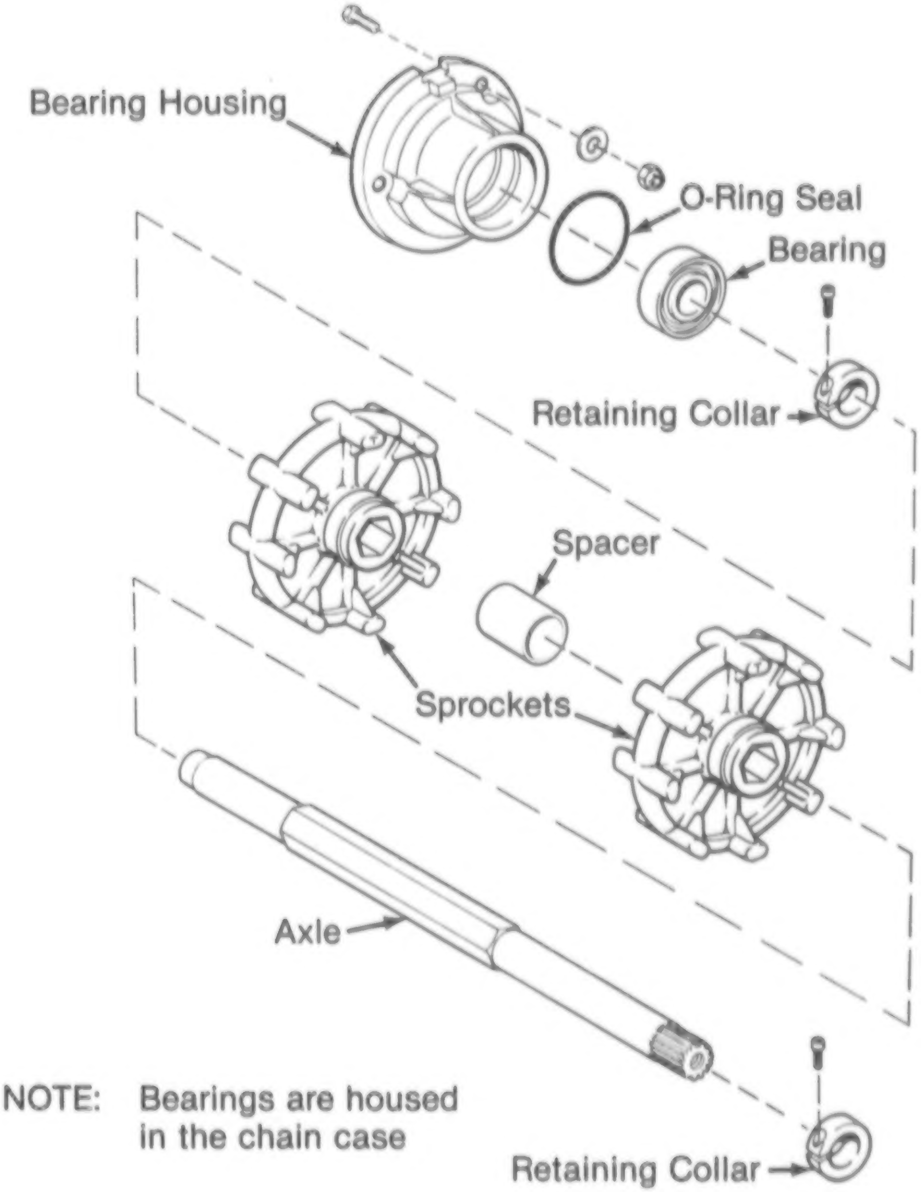
C. Most drive axle bearing opposite the chain case side are sealed bearings and can not be serviced, these must be replaced if found defective.

D. Occasionally the drive axle shaft may be bent by impact with hard objects at fast speeds and may require replacement.

E. Missing track inserts can cause chipped or broken teeth on drive sprockets.

F. Track misalignment can cause excessive wear to the sprockets, the track, and bearings.

Parts of a Drive Axle


Bearing Housing
O-Ring Seal
Bearing
Retaining Collar
Spacer
Sprockets
Axle
Retaining Collar

NOTE: Bearings are housed in the chain case

Courtesy Kawasaki Motors Corp., U.S.A.

JACKSHAFTS AND AXLES
UNIT VII

ASSIGNMENT SHEET #1 — SOLVE PROBLEMS RELATED TO AXLE REPAIR AND MAINTENANCE

Directions: Read the following problems carefully and respond as directed.

A. You have been asked to conduct routine inspection and maintenance of a snowmobile. What routine inspection should you do regarding the axle?

____

____

B. During your inspection you find that there are some missing inserts on the track. What might you expect the affect to be on the axle sprocket(s)?

____

____

C. The efficient transfer of power from the engine to the track is partly accomplished through the use of shafts. What are those shafts, and in what order do they function in power transfer from the engine to the track?

____

____

D. The owner tells you that his snowmobile struck a hidden tree trunk when traveling at about 30 mph. What damage to the axle could be possible?

____

____

JACKSHAFTS AND AXLES
UNIT VII

ANSWERS TO ASSIGNMENT SHEET

A. First, inspect the bearings on the axle. If they are the non-lubricating type, examine them for excessive wear. If they are lubricated by oil from the chain case, inspect the chain case pan to see if it contains sufficient oil for lubricating. Inspect the alignment of the track. Inspect sprockets for wear.

B. Missing track inserts can cause chipped or broken teeth on the drive sprockets. The inserts should be replaced and the sprockets replaced if necessary.

C. The main shafts are the crankshaft to which the drive clutch is attached, power is then transmitted to the jackshaft which in turn transmits power through the chain drive to the drive axle which transmits power finally to the track.

D. You might suspect a bent front or rear axle which may have to be replaced.

JACKSHAFTS AND AXLES
UNIT VII

JOB SHEET #1 — REMOVE AND INSTALL A JACKSHAFT

A. Tools and materials needed

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Basic hand tools
4. Shim kit (if applicable)
5. Bearing puller (as per manufacturer's specifications)
6. Alignment tool
7. Lubricant as required
8. Safety glasses

B. Routine #1 — Removing the jackshaft

1. Put on safety glasses.
2. Remove the chain case cover and sprockets, and the chain case.

   (NOTE: Refer to UNIT VI if necessary.)

3. Remove the driven clutch.
4. Loosen the lock collar, and remove the flange and bearing on the left side of the jackshaft.
5. Remove the jackshaft and disc while the sled sits on the ground.

☐ Have your instructor check your work.

C. Routine #2 — Installing the jackshaft

1. Install the chaincase to the chassis with the jackshaft, but do not install the sprockets.
2. Install the alignment tool according to manufacturer's specifications.

JOB SHEET #1

3. Install flange into the left bearing support hole.
    a. The shaft should center in the flange.
    b. If the shaft does not center in flange, use a shim kit to position the shaft on center by placing shims in the chain case between the tunnel and case.
4. Grease the left bearing and flange.
5. Slide the bearing onto the shaft.
6. Rotate the flanges to inspect for binding which can cause misalignment.
7. Tighten flanges.

    (NOTE: Always torque nuts and bolts to specifications.)
8. Use a straight edge on the support plate to check for movement of the plate by rotating the shaft.
9. Correct any movement by loosening the flange mounting bolts slightly and gently tap the flange while rotating the shaft until no movement exists.

☐ Have your instructor check your work.

10. Clean up area and return tools and materials to proper storage.

JACKSHAFTS AND AXLES
UNIT VII

JOB SHEET #2 — DISASSEMBLE A DRIVE AXLE ASSEMBLY

A. Tools and materials needed

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Basic hand tools
4. Bearing puller
5. Vise
6. Large snap-ring pliers
7. Empty container to catch oil
8. Clean shop towels
9. Solvent
10. Safety glasses

B. Procedure

1. Put on safety glasses.
2. Drain oil from chain case.
3. Remove chain case or chain case inspection cover from snowmobile to expose sprockets.
4. Remove nut, bolt or cotter pin holding sprocket onto drive axle.
5. Remove sprocket from spline of drive axle.
6. Support back end of snowmobile so that the track can be loosened or removed.
7. Loosen all bolts supporting the track.
8. Remove slide rail or bogie wheel assembly.
9. Remove bearing support opposite chain case.

JOB SHEET #2

10. Slide axle opposite chain case and remove from frame.

    (NOTE: Some models may locate a speedometer drive or brake assembly on this end of the drive shaft, and these components may have to be removed.)

11. Clamp axle into vise and pull off bearings with appropriate puller.

12. Remove seals.

13. Remove sprockets from drive axle.

14. Clean all parts with solvent and wipe dry with a clean shop towel.

15. Inspect bearings, seals, and sprockets for damage.

☐ Have your instructor check your work.

16. Clean up area and return tools and materials to proper storage or prepare for next job sheet as directed by your instructor.

(Note: Do not clean sealed bearings in solvent. If the bearing is useable, the solvent may leak into the bearing and compromise the lubricating grease installed during manufacture. If the sealed bearing does not turn freely and smoothly, it is defective and must be replaced).

JACKSHAFTS AND AXLES
UNIT VII

JOB SHEET #3 — REASSEMBLE A DRIVE AXLE ASSEMBLY

A. Tools and materials needed

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Bearing driver set
4. Seals as required
5. Sprockets as required
6. Vise
7. Large snap-ring pliers
8. Oil per specifications
9. Clean shop towels
10. Safety glasses

B. Procedure

1. Put on safety glasses.
2. Install sprockets onto drive axle.
3. Install seals.
4. Drive bearings onto drive axle with bearing driver.
5. Insert drive axle into frame with track in place.
6. Install bearing support on side opposite chain case, and reinstall speedometer drive or brake assembly as required.
7. Install slide suspension system and rear axle.
8. Slip drive chain sprocket onto spline of axle.

JOB SHEET #3

9. Reinstall drive chain.

   (NOTE: Chain may have to be installed with sprockets.)

10. Install chain case cover.

11. Fill chain case with oil to the proper level.

12. Align and adjust track.

13. Check operation.

☐ Have your instructor check your work.

14. Clean up area and return tools and materials to proper storage.

JACKSHAFTS AND AXLES
UNIT VII

NAME ______________________

TEST

1. Match terms related to jackshafts and axles with their correct definitions.

_______a. A solid or semi-solid shaft of steel which connects to the drive chain by a sprocket and drives the track.

______b. A shaft which extends across the chassis from the driven clutch and down to the chain case serving to transfer power from one side of the snowmobile to the other; found on most high performance models

______c. Large wheels connected to the drive axle used to turn the track; virtually all snowmobiles use internal drive sprockets

______d. The portion of the drive sprocket that inserts into or receives a raised portion of track to turn the track

______e. Rubber washer used to seal the chain case where the drive axle or jackshaft enters into the case; used to eliminate oil leakage

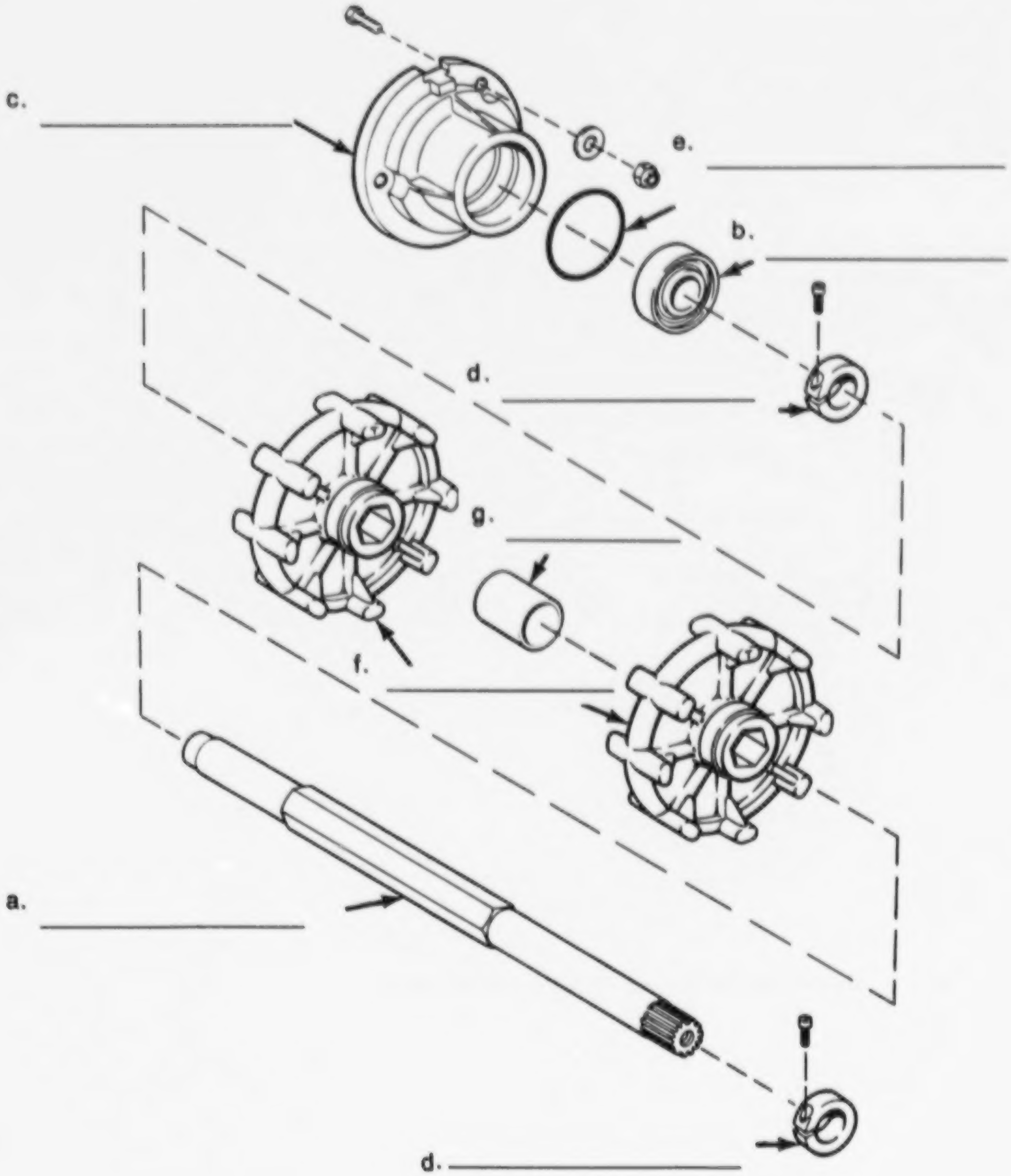
______f. A plate used to secure the drive sprockets to the drive axle

______g. The rear shaft with sprockets to allow the track to rotate on the snowmobile

1. Drive sprockets
2. Seal
3. Drive axle
4. Rear axle
5. Flange
6. Teeth
7. Jackshaft

TEST

2. Identify major components of a drive axle assembly by placing the correct component name in the appropriate blank.



TEST

3. Complete statements concerning types of axles by inserting the word(s) that best complete each statement.

   a. A jackshaft is driven by the ____________ ____________ and transfers power across the snowmobile chassis to the chain case while facilitating a lower profile for the machine.

   b. A drive axle accepts power from the ____________ ____________ and transfers it by the sprocket to the track.

   c. The rear axle is an idling axle at the rear of the snowmobile where it ____________ the track as it moves around the rear end of the chassis.

4. Select true statements concerning axle repair by placing an "X" beside each statement that is true.

   _____a. Virtually no maintenance is required of the axles except to see that bearings on the sprockets are lubricated if they are the lubricating type.

   _____b. Most bearings have a Duralon bushing which requires lubrication.

   _____c. Some axles have bearings which are lubricated inside the chain case.

   _____d. Occasionally the shaft of the axle may be bent by impact with hard objects at fast speeds and may require replacement.

   _____e. Missing track inserts can cause chipped or broken teeth on drive sprockets.

   _____f. Track alignment can cause excessive wear to the sprockets, the track, and the bearings.

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

5. Solve problems related to axle repair and maintenance. (Assignment Sheet #1)

6. Demonstrate the ability to:

   a. Remove and install a jackshaft. (Job Sheet #1)

   b. Disassemble a drive axle assembly. (Job Sheet #2)

   c. Reassemble a drive axle assembly. (Job Sheet #3)

JACKSHAFTS AND AXLES
UNIT VII

ANSWERS TO TEST

1. a. 3
   b. 7
   c. 1
   d. 6
   e. 2
   f. 5
   g. 4

2. a. Axle
   b. Bearing
   c. Bearing housing
   d. Retaining collar
   e. Seal (O-ring)
   f. Sprockets
   g. Spacer

3. a. Driven clutch
   b. Chain drive
   c. Supports

4. [illegible], c, d, e

5. Evaluated to the satisfaction of the instructor

6. Performance skills evaluated according to procedures written in the job sheets

REAR SUSPENSION
UNIT VIII

UNIT OBJECTIVE

After completion of this unit, the student should be able to discuss the purpose and function of the rear suspension system and be able to identify the components of a rear suspension. The student should also be able to perform simple maintenance on a slide rail system, disassemble and reassemble a slide rail suspension, and replace wear strips. These competencies will be evidenced by correctly performing the procedures outlined in the assignment and job sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to rear suspension with their correct definitions.
2. Complete statements concerning the slide rail suspension system.
3. Identify components of a slide rail suspension.
4. Select true statements concerning maintenance.
5. Solve problems related to rear suspension maintenance. (Assignment Sheet #1)
6. Demonstrate the ability to:
    a. Disassemble and reassemble a slide rail suspension. (Job Sheet #1)
    b. Replace wear strips. (Job Sheet #2)

REAR SUSPENSION
UNIT VIII

SUGGESTED ACTIVITIES

A. Provide students with objective sheet.

B. Provide students with information sheet.

C. Make transparency.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Demonstrate and discuss the procedures outlined in the job sheets.

G. Have available to students an old model snowmobile featuring the bogie wheel suspension system, and a new model snowmobile featuring the slide rail suspension, and have the students compare the two systems.

H. Give test.

CONTENTS OF THIS UNIT

A. Objective sheet

B. Information sheet

C. Transparency Master 1 — Parts of a Slide Rail Suspension

D. Assignment Sheet #1 — Solve Problems Related to Rear Suspension Maintenance

E. Answers to assignment sheet

F. Job sheets

   1. Job Sheet #1 — Disassemble and Reassemble a Slide Rail Suspension

   2. Job Sheet #2 — Replace a Wear Strip

G. Test

H. Answers to test

REFERENCES USED IN DEVELOPING THIS UNIT

A. *Snowmobile Repair.* Stillwater, OK 74074: Mid-America Vocational Curriculum Consortium, 1976.

B. *Chilton's Snowmobiles Repair & Turn-Up Guide,* Second edition. Radnor, PA: Chilton Book Co., 1975.

C. *Arctic Cat Service Manual No. 2254-302.* Thief River Falls, MN 56701: ARCTCO, Inc., 1984.

D. *1980 Bombardier Snowmobiles Shop Manual.* Valcourt, Quebec, Canada: Bombardier, Ltd., 1980.

E. *Kawasaki Invader Snowmobile Shop Manual.* Santa Ana, CA 92799-5252: Kawasaki Motors Corp., U.S.A., 1980.

REAR SUSPENSION
UNIT VIII

INFORMATION SHEET

I. **Terms and definitions**

A. Cross shaft — Used to mount the slide rail suspension onto the snowmobile chassis

B. Idler wheels — Wheel assemblies used to apply tension to the track and keep the slide rail from hitting the track

C. Suspension springs — Used to give the slide rail suspension action

D. Slider — Usually made of nylon and guided by inserts in the track

(NOTE: This rail is lubricated by snow.)

E. Runner bars — Used to attach the nylon slide rail.

F. Wear strip — An under rib attached to the bottom of the slide rail to protect the slide rail from track friction

G. Rear axle — A solid or hollow shaft which connects the link plates and is used to control track tension and also to guide the track alignment

H. Link plates — Used to connect the rear axle to the frame and allow the suspension to flex with the weight of the rider

I. Rear spring — Used to apply pressure to the link plate to stiffen and lighten the flexibility of the suspension

J. Rear sprockets — Connect to the rear axle and are used as idlers to control track tension and track alignment

K. Rear bearings — Inserted into the link plates and are used to eliminate friction on the rear axle

L. Rear seal — Used to hold grease in the rear link plates so that the bearings will remain lubricated

M. Bogie wheel assembly — An assembly of wheels mounted to a snowmobile frame between the top and bottom of the track to support the weight of the rider and to absorb shock caused by hitting objects; mostly outdated and replaced by the slide rail suspension system

II. **The slide rail suspension system** (Figure 1)

A. Uses a plastic-lined rail to press against the inside of the track to guide the track over snow

B. The snowmobile's weight is carried by the slide rail.

INFORMATION SHEET

C. Slide rail suspensions are used on virtually all racing sleds and are considered most effective when used in deep snow.

D. Spring loaded levers press the slide rail against the track.

E. The slide rail requires powdered snow to lubricate and cool the plastic slide which is in constant contact with the track.

F. The advantage of a slide rail suspension over a bogie wheel suspension is that it applies more track pressure to the ground and less friction to the track.

III. **Components of a slide rail suspension** (Transparency #1)

A. Runner bars

B. Wear strips

C. Idler wheels

D. Shock absorber

E. Rear axle

F. Front and rear adjustment springs

G. Cross shafts

H. Front and rear arm brackets

I. Bearings and fastening devices

IV. **Maintenance**

A. The slide rail is designed to operate with adequate snow cover to provide sufficient lubrication.

B. Excessive wear to the wear strips may be due to improper alignment or riding on surfaces without snow.

C. Replacement of the wear strips is one common maintenance procedure performed on the rear suspensions, and when wear strips are worn to 1/8" at any spot, they should be replaced.

D. Proper alignment is when the rear idler wheels are equal distance from the inner drive lugs or from the outside edge of the track.

E. The most common maintenance performed to the rear suspension is adjustment of the front and rear springs for proper tension.

INFORMATION SHEET

F. The rear suspension spring is adjusted for the weight and riding preference of the snowmobile operator.

G. If an operator jumping up and down on the rearmost part of the running board can "bottom out," it is a good test that indicates that rear suspension is properly adjusted.

H. The front suspension spring influences snowmobile handling in snow, and the effort required to steer the snowmobile.

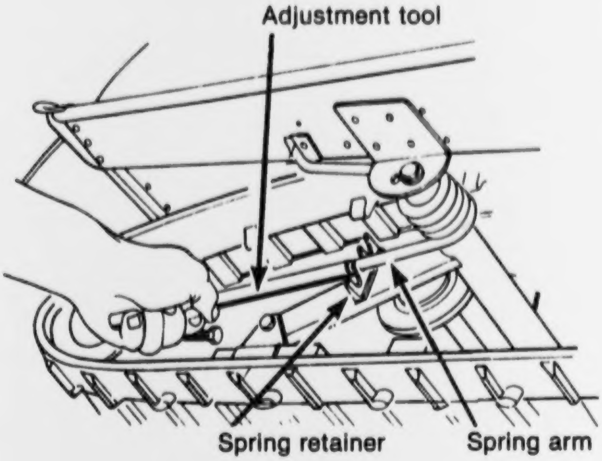
I. The optimum setting for front spring tension is when tension is sufficiently stiff to prevent the suspension from collapsing in deep snow, but not stiff enough to cause steering to be difficult.

J. Spring tension on some systems is adjustable by tightening or loosening the lock nut on the eyebolt attached to the spring on both sides.

K. Some spring tension adjustment has to be made with an adjustment cam.

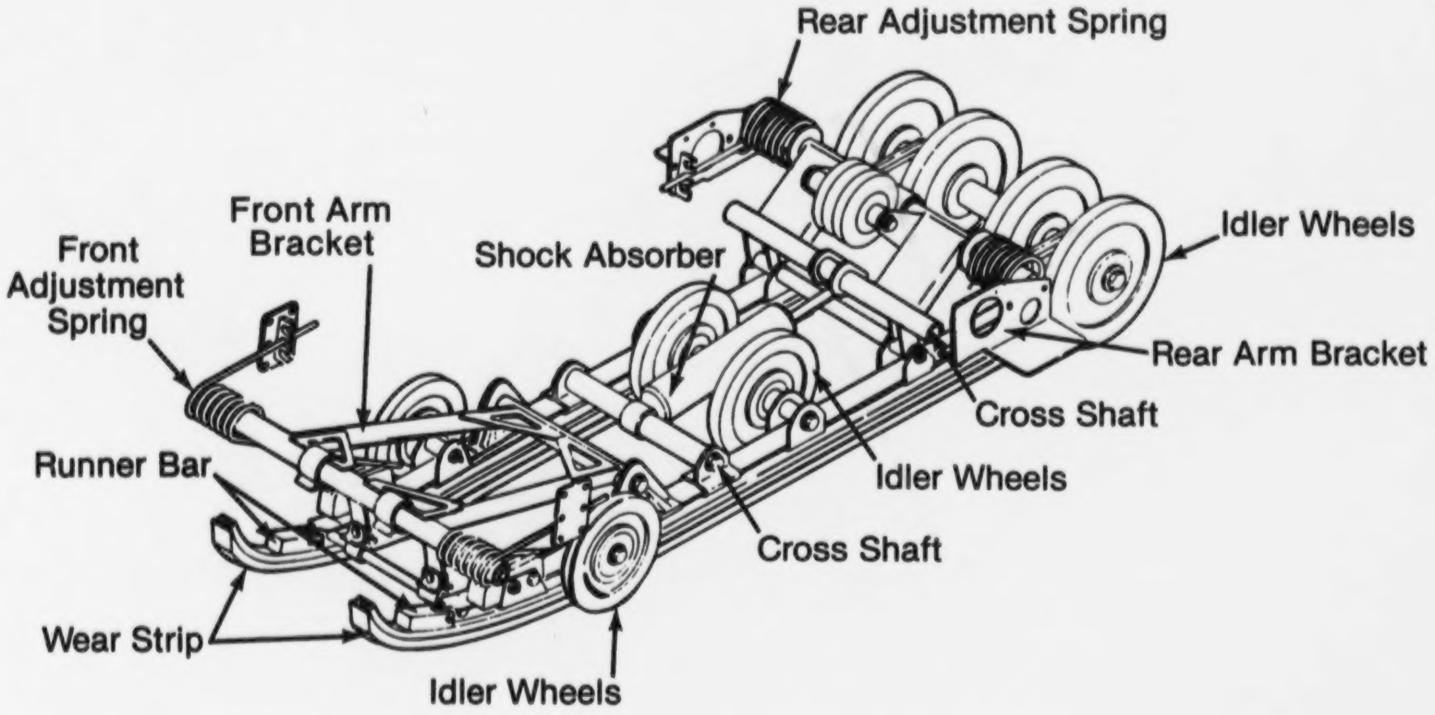
L. Some spring tension adjustment has to be made by moving a spring into a higher or lower retaining notch. (Figure 1)

FIGURE 1



Courtesy Kawasaki Motors Corp., U.S.A.

Parts of a Slide Rail Suspension


Rear Adjustment Spring
Front Arm Bracket
Front Adjustment Spring
Shock Absorber
Idler Wheels
Rear Arm Bracket
Cross Shaft
Runner Bar
Idler Wheels
Cross Shaft
Wear Strip
Idler Wheels

Courtesy Kawasaki Motors Corp., U.S.A.

REAR SUSPENSION
UNIT VIII

ASSIGNMENT SHEET #1 — SOLVE PROBLEMS RELATED TO REAR SUSPENSION MAINTENANCE

Directions: Read the following problems carefully and respond as directed.

A. You have been asked by your instructor to explain to the rest of the class the purpose of the rear suspension system, and why the slide rail suspension system has been adopted over the bogie wheel system. How would you respond?

____

____

B. Why is a slide rail suspension system most efficient on surfaces with powdered snow?

____

____

C. The operator of a snowmobile with slide rail suspension complains to you about the ride being too springy. What would you suspect is the problem and how would you correct it?

____

____

D. On routine inspection of a slide rail you notice the wear strip becoming thin. At what point should the wear strip be replaced?

____

____

REAR SUSPENSION
UNIT VIII

ANSWERS TO ASSIGNMENT SHEET

A. The rear suspension carries the weight of the snowmobile and operator and serves to press against the inside of the track to guide the track over the snow. Its advantages over the bogie wheel system are that it applies greater pressure from the track onto the ground, and creates less friction with the track.

B. The slide rail requires powdered snow to lubricate and to cool the plastic slide which is in contact constantly with the track.

C. The rear spring is responsible for carrying the weight of the operator. In this case it is probably not adjusted properly; there is too little tension in the spring, and the problem can be corrected by increasing spring tension.

D. When the slide rail wear strip is worn down to 1/8" in any portion of the material, it should be replaced.

REAR SUSPENSION
UNIT VIII

JOB SHEET #1 — REMOVE AND REINSTALL A SLIDE RAIL SUSPENSION

A. Tools and materials

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Pry bar
4. Ball peen hammer
5. Cardboard or protective material
6. Service stand
7. Manufacturer's specified spring tool
8. LOCTITE (if specified by manufacturer)
9. Torque wrench
10. Safety glasses

B. Routine #1 — Removing the slide rail

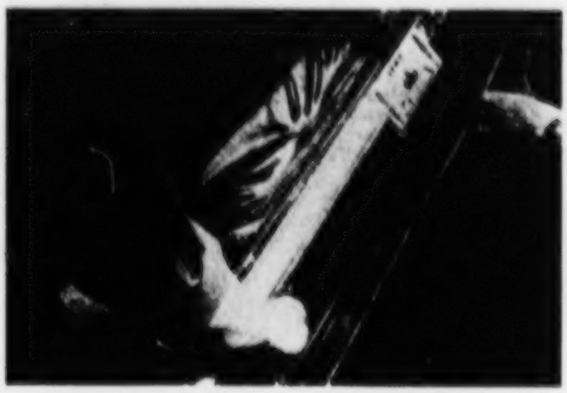
1. Put on safety glasses
2. Tilt the snowmobile on its side onto a sheet of cardboard to protect the cowling, or lift the rear of the sled onto a service stand.
3. Loosen track tension by loosening the adjuster bolts located on the inner side of the rear idler wheels. (Some models will vary.)

(CAUTION: Release tension on front and rear suspension adjustment springs by unhooking springs from rear and forward arm brackets. Use appropriate tool to hold spring and release tension gradually keeping hands and fingers away from spring ends and suspension parts until spring tension is released.)

JOB SHEET #1

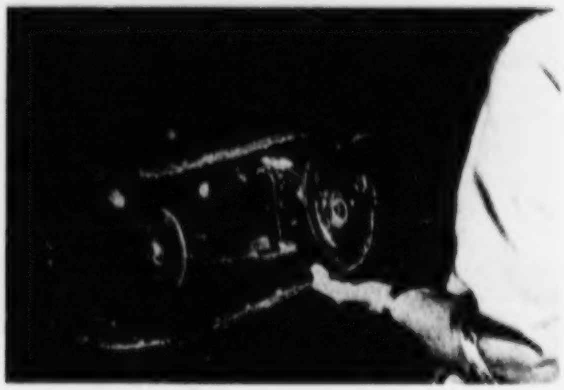
4. Remove bolts from the cross shafts. (Figure 1)

FIGURE 1



5. Lower slide rail and track as an assembly, and get a co-worker to help if the rail and track are too heavy. (Figure 2)

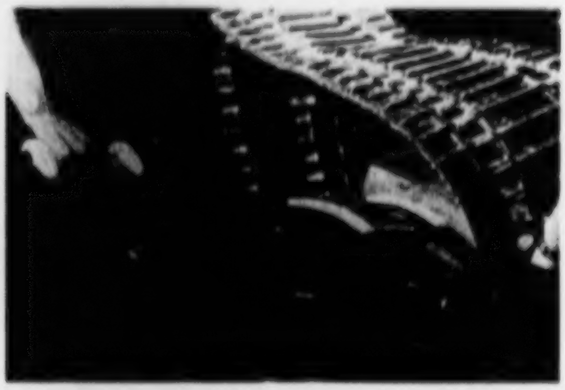
FIGURE 2



JOB SHEET #1

6. Pull slide rail suspension from the track. (Figure 3)

FIGURE 3



7. Inspect the slide rails and wear strips for wear.

8. Clean for reassembly.

☐ Have your instructor check your work

C. Routine #2 — Reinstalling the slide rail

1. Leave safety glasses on.

2 Insert slide rail unit into snowmobile.

3. Bolt front cross shaft to frame.

4. Bolt rear cross shaft to frame.

5. Hook springs on both sides.

6. Tighten track tension according to manufacturer's specifications.

7. Align track.

☐ Have your instructor check your work.

8. Test run the vehicle only if your instructor tells you to.

9. Clean up area and return tools and materials to proper storage.

REAR SUSPENSION
UNIT VIII

JOB SHEET #2 — REPLACE WEAR STRIPS

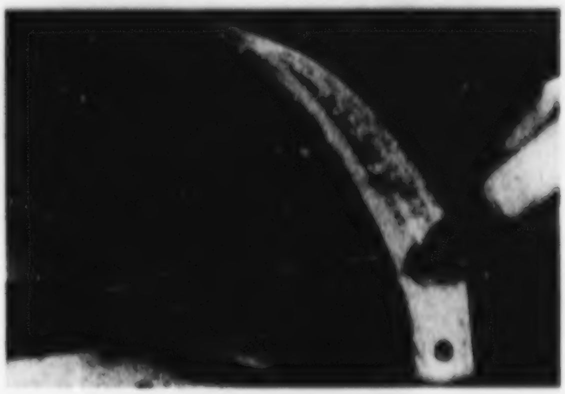
A. Tools and materials

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Cold chisel
4. Drive and $^3/_{16}$" drill bit
5. Ball peen hammer
6. Block of wood
7. Replacement wear strips
8. Safety glasses

B. Procedure

1. Put on safety glasses
2. Remove the suspension from the snowmobile as outlined in Job Sheet #1.
3. Inspect the wear strip for excessive or irregular wear or for any spot where the strip(s) has worn to within $^1/_8$". (Figure 1)

FIGURE 1



JOB SHEET #2

4. Place new wear strips out where they can warm to room temperature if you plan to replace the wear strips.

5. Drill out the rivet heads that secure the old wear strips to the slide rail. (Figure 2)

FIGURE 2

6. Drive the wear strips rearward off the runners with a block of wood and a ball peen hammer.

7. Drive new wear strips into place only after they have warmed to room temperature.

8. Rivet the new wear strips to the runners with the proper size pop rivet.

☐ Have your instructor check your work

9. Clean up area and return tools and materials to proper storage.

REAR SUSPENSION
UNIT VIII

NAME ______________________

TEST

1. Match terms related to rear suspension with their correct definitions.

_____a. Used to mount the slide rail suspension onto the snowmobile chassis

_____b. Wheel assemblies used to apply tension to the track and keep the slide rail from hitting the track

_____c. Used to give the slide rail suspension action

_____d. Usually made of nylon and guided by inserts in the track

_____e. Used to attach the nylon slide rail

_____f. An under rib attached to the bottom of the slide rail to protect the slide rail from track friction

_____g. A solid or hollow shaft which connects the link plates and is used to control track tension and also to guide the track alignment

_____h. Used to connect the rear axle to the frame and allow the suspension to flex with the weight of the rider

_____i. Used to apply pressure to the link plate to stiffen and lighten the flexibility of the suspension

_____j. Connect to the rear axle and are used as idlers to control track tension and track alignment

_____k. Inserted into the link plates and are used to eliminate friction on the rear axle

_____l. Used to hold grease in the rear link plates so that the bearings will remain lubricated

_____m. An assembly of wheels mounted to a snowmobile frame between the top and bottom of the track to support the weight of the rider and to absorb shock caused by hitting objects; mostly outdated and replaced by the slide rail suspension system

1. Wear strip
2. Slider
3. Link plates
4. Rear spring
5. Rear axle
6. Cross shaft
7. Rear sprockets
8. Suspension springs
9. Bogie wheel assembly
10. Rear bearings
11. Runner bars
12. Idler wheels
13. Rear seal

TEST

2. Complete statements concerning the slide rail suspension system by inserting the word(s) that best completes each statement.

   a. Uses a _____________-lined rail to press against the inside of the track to guide the track over snow.

   b. The snowmobile's _____________ is carried by the slide rail.

   c. Slide rail suspensions are used on virtually all _____________ sleds and are considered most effective when used in deep snow.

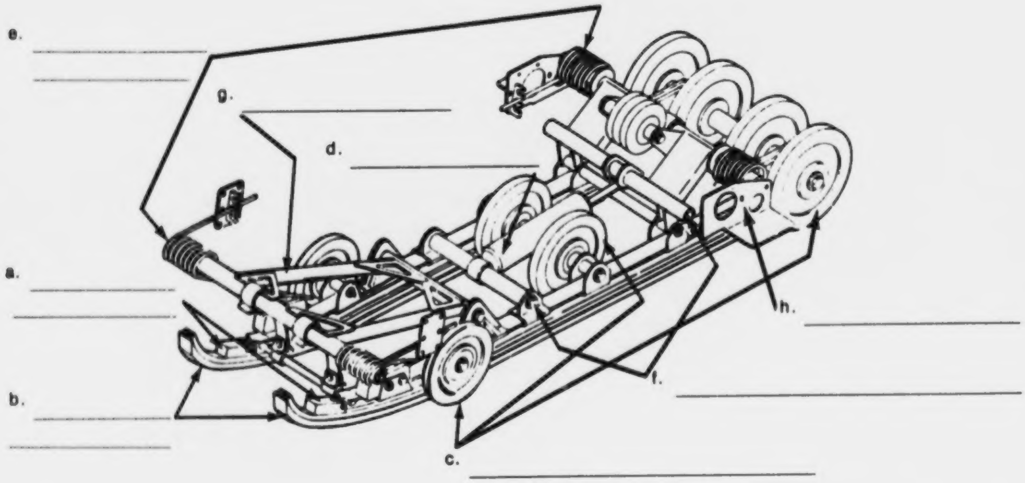
   d. Spring loaded levers _____________ the slide rail against the track.

   e. The slide rail requires _____________ snow to lubricate and cool the plastic slide which is in constant contact with the track.

   f. The advantage of a slide rail suspension over a bogie wheel suspension is that it applies _____________ track pressure to the ground and less friction to the track.

TEST

3. Identify components of a slide rail suspension by placing the correct part name in the appropriate blank.



TEST

4. Select true statements concerning maintenance by placing an "X" beside each statement that is true.

_____a. The slide rail is designed to operate with adequate snow cover to provide sufficient lubrication.

_____b. Excessive wear to the wear strips may be due to proper alignment or riding on surfaces with snow.

_____c. Replacement of the wear strips is one common maintenance procedure performed on the rear suspensions, and when wear strips are worn to 1/8" at any spot, they should be replaced.

_____d. Proper alignment is when the rear idler wheels are equal distance from the inner drive lugs or from the outside edge of the track.

_____e. The most common maintenance performed to the rear suspension is adjustment of the front idler wheel for proper tension.

_____f. The rear suspension spring is adjusted for the weight and riding preference of the snowmobile operator.

_____g. If an operator jumping up and down on the rearmost part of the running board can "bottom out," it is a good test that indicates that rear suspension is improperly adjusted.

_____h. The front suspension spring influences snowmobile handling in snow, and the effort required to steer the snowmobile.

_____i. The optimum setting for front spring tension is when tension is sufficiently stiff to prevent the suspension from collapsing in deep snow, but not stiff enough to cause steering to be difficult.

_____j. Spring tension is not adjustable by tightening or loosening the lock nut on the eyebolt attached to the spring on both sides.

_____k. Some spring tension adjustment has to be made with an adjustment cam.

_____l. Some spring tension adjustment has to be made by moving a spring into a higher or lower retaining match.

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

5. Solve problems related to rear suspension maintenance. (Assignment Sheet #1)

6. Demonstrate the ability to:

   a. Disassemble and reassemble a slide rail suspension. (Job Sheet #1)

   b. Replace wear strips. (Job Sheet #2)

REAR SUSPENSION
UNIT VIII

ANSWERS TO TEST

1. a. 6
   b. 12
   c. 8
   d. 2
   e. 11
   f. 1
   g. 5
   h. 3
   i. 4
   j. 7
   k. 10
   l. 13
   m. 9

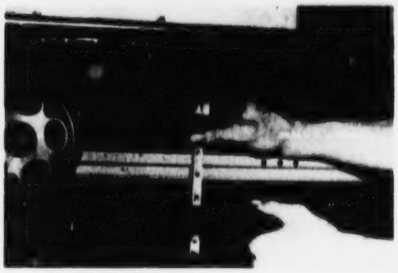
2. a. Plastic
   b. Weight
   c. Racing
   d. Press
   e. Powdered
   f. More

3. a. Runner bar
   b. Wear strip
   c. Idler wheels
   d. Shock absorber
   e. Rear axle
   f. Front and rear adjustment springs
   g. Cross shaft
   h. Front and rear arm brackets

4. a, c, d, f, h, i, k, l

5. Evaluated to the satisfaction of the instructor

6. Performance skills evaluated according to procedures written in the job sheets



TRACKS
UNIT IX

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify types of track and discuss the procedures required for track maintenance. The student should also be able to remove and replace a track, adjust track tension and alignment, singe a track, and replace track guide clips. These competencies will be evidenced by correctly performing the procedures outlined in the assignment and job sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to tracks with their correct definitions.
2. Identify types of tracks.
3. Select true statements concerning causes of track failure.
4. Complete statements concerning track tension and alignment.
5. Arrange in order the steps in track tension alignment.
6. Complete statements concerning singeing a track.
7. Solve problems related to track maintenance. (Assignment Sheet #1)
8. Demonstrate the ability to:
    a. Remove and replace a track. (Job Sheet #1)
    b. Adjust track tension and alignment. (Job Sheet #2)
    c. Singe a track. (Job Sheet #3)
    d. Replace track guide clips. (Job Sheet #4)

TRACKS
UNIT IX

SUGGESTED ACTIVITIES

A. Provide students with objective sheet.

B. Provide students with information sheet.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Demonstrate and discuss the procedures outlined in the job sheets.

G. Ask a snowmobile manufacturer, or a manufacturer of tracks, to supply you with audio visuals which describe how tracks are made, their composition, types, and their maintenance requirements.

H. Visit different snowmobile dealers to examine the various types of tracks which are available for different makes and models of snowmobiles.

I. Give test.

CONTENTS OF THIS UNIT

A. Objective sheet

B. Information sheet

C. Transparency masters

  1. TM 1 — Internal Drive Track
  2. TM 2 — Rubber Track with Reinforcement
  3. TM 3 — Cleated Track

D. Assignment Sheet #1 — Solve Problems Related to Track Maintenance

E. Answers to assignment sheet

F. Job sheets

  1. Job Sheet #1 — Remove and Replace a Track
  2. Job Sheet #2 — Adjust Track Tension and Alignment

CONTENTS OF THIS UNIT

F. Job sheets

1. Job Sheet #1 — Remove and Replace a Track
2. Job Sheet #2 — Adjust Track Tension and Alignment
3. Job Sheet #3 — Singe a Track
4. Job Sheet #4 — Replace Track Guide Clips

G. Test

H. Answers to test

REFERENCES USED IN DEVELOPING THIS UNIT

A. *Snowmobile Repair.* Stillwater, OK 74074: Mid-America Vocational Curriculum Consortium, 1976.

B. *Arctic Cat Service Manual No. 2254-302.* Thief River Falls, MN 56701: ARCTCO, 1984.

C. *1980 Bombardier Snowmobiles Shop Manual.* Valcourt, Quebec, Canada: Bombardier, Ltd., 1980.

TRACKS
UNIT IX

INFORMATION SHEET

I. **Terms and definitions**

A. Track — A rubberized belt with metal guide clips that transfer power from the axle sprockets to the entire belt which has exterior molded cleats to grab the snow and help keep a snowmobile moving

B. Guide clips — Metal clips inserted into the track to eliminate wear to the track by the sprockets

C. Track tension — The tightness or looseness of the track

D. Track alignment — Equal track distance on both sides of the snowmobile frame

E. Cords — Nylon cords molded into the track to give it strength

F. Singeing — Burning or melting frayed ends which occur as the track begins to wear

G. Rods - Steel rods (early models) or fiberglass rods (latter models) molded into the track to make it rigid and give the track strength.

II. **Types of tracks**

A. Internal drive track (Transparency 1)

B. Rubber track with steel or fiberglass rods molded into it (Transparency 2)

C. Cleated track found only on older model snowmobiles (Transparency 3)

III. **Causes of track failure**

A. Cuts caused by running over sharp objects are the most frequent cause of track failure.

B. The track not being aligned for a long period of time is a common cause of track failure.

C. Broken cleats, on older models, if not repaired, can damage the track.

D. Worn sprockets on the axle can damage the track.

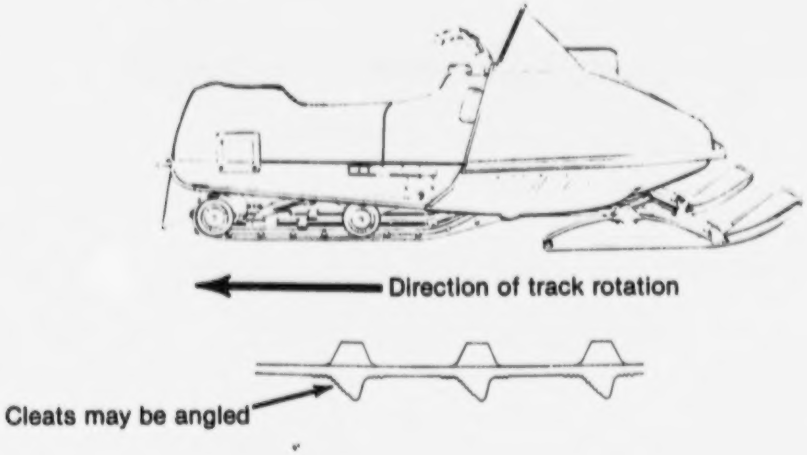
E. Normal wear will eventually require track replacement.

F. Tension on the track must be correct or abnormal wear can occur.

INFORMATION SHEET

G. Track must be installed or replaced so that it rotates in the proper direction of travel. (Figure 1)

FIGURE 1



Courtesy Kawasaki Motors Corp., U.S.A.

IV. Track tension and alignment

A. Track tension and alignment are interrelated.

B. Always establish the correct tension before checking and adjusting alignment.

C. To inspect track tension, slide a gloved hand along the inside of the chassis tunnel and vigorously push the underside of the track up and down; the track must not hit the top of the tunnel or slap against the skid frame.

D. Proper track alignment occurs when the rear idler wheels are equal distance from the inner drive lugs of the track or the outside edge of the track.

V. Steps in track tension inspection

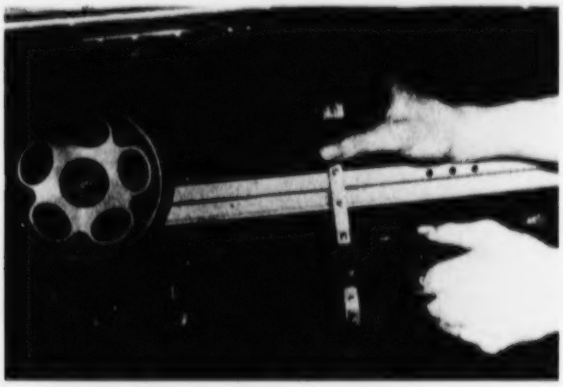
A. Raise the rear of the sled safely off the ground.

B. Apply about 5 to 10 pounds of pull downward at the center of the track.

INFORMATION SHEET

C. Measure for a distance of about 1/2" to 1" between the slide rail and the track. (Figure 2)

FIGURE 2



D. If the slide rail to track distance is more or less than manufacturer's specifications, the track should be adjusted.

VI. **Singeing a track**

A. Singeing the track is a technique that burns frayed track cords caused by track wear.

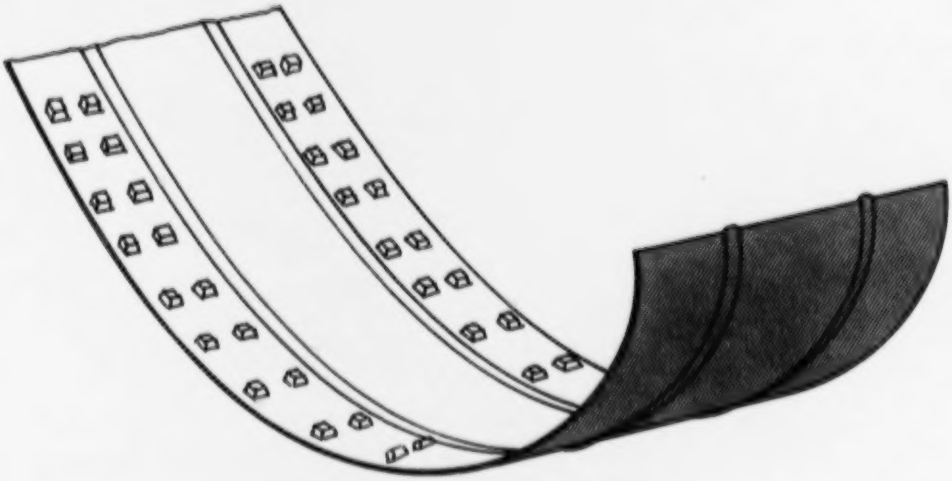
B. Frayed cords left on a track will accelerate more track wear, so singeing will help increase track life and improve the appearance of the sled.

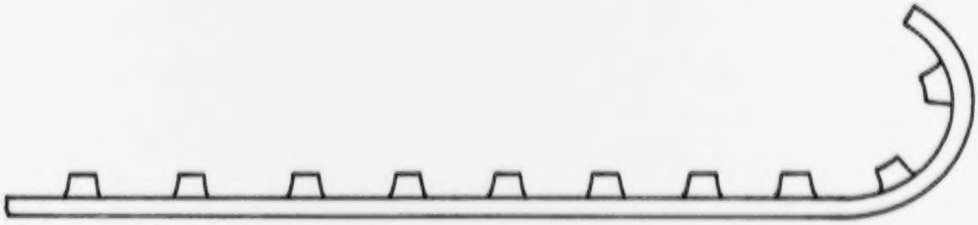
C. Singeing is best accomplished by burning off frayed track with a propane torch, but safety must be a prime concern during the procedure.

D. Rules for singeing a track are:

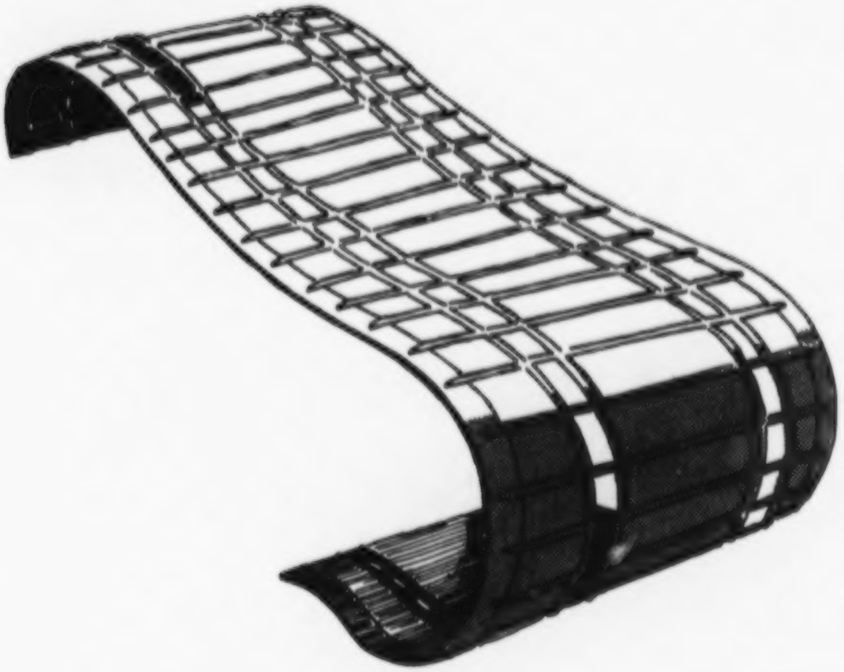
1. Make sure the area is free of flammable materials and that there is a fire extinguisher handy.
2. Make sure the engine is stopped and the ignition off.
3. Keep a heavy, wet rag handy for quinching track areas after they have been singed.
4. Be careful not to overheat the track edges and damage the track's rubber base.

Internal Drive Track

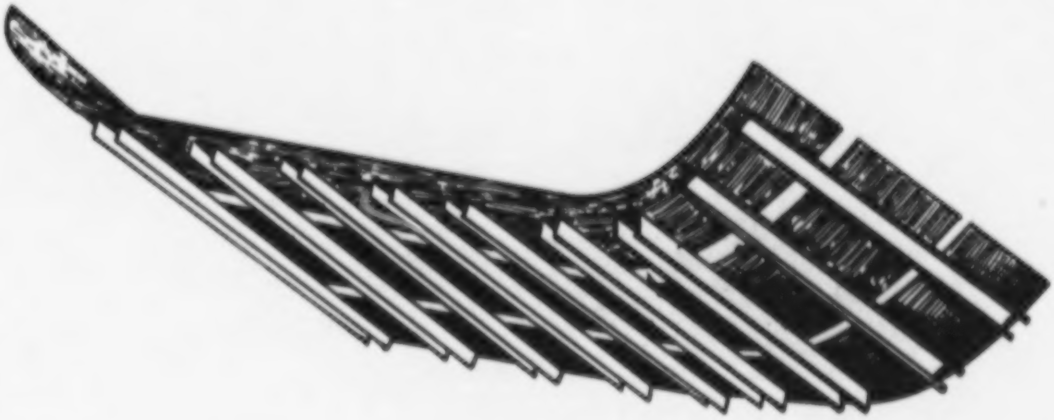


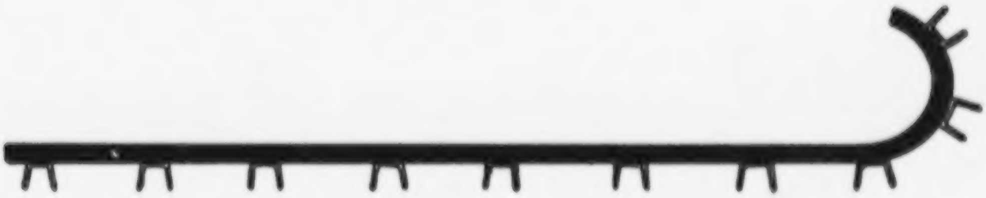


Rubber Track With Reinforcement



Cleated Track





TRACKS
UNIT IX

ASSIGNMENT SHEET #1 — SOLVE PROBLEMS RELATED TO TRACK MAINTENANCE

Directions: Read the following problems carefully and respond as directed.

A. Describe briefly what track alignment is and its importance to the function of the track.

B. What safety precautions must always be taken when checking for alignment of the track?

C. What is singeing, and why should a track be singed?

D. What safety precautions must be taken when singeing the track?

TRACKS
UNIT IX

ANSWERS TO ASSIGNMENT SHEET

A. Track alignment is when the rear idler wheels are equal distance from the inner drive lugs or the outside edge of the track. Alignment provides for the axle sprockets to insert into the guide clips smoothly so that the efficient transfer of power from the drive system is transmitted to the track.

B. Always inspect the track for particles of dirt or rocks which might be thrown from the track when it is rotating. Always use safe procedures and always see that the tips of the skis are positioned against a wall. Never allow anyone to stand in front or behind the track while it is revolving.

C. Singeing burns frayed cords off a track. Singeing promotes track life and makes a sled look better.

D. Always keep a wet, heavy rag available to douse any fires on the track. Always check the snowmobile and the area around the snowmobile for any flammable materials. Always keep the engine stopped and ignition off.

TRACKS
UNIT IX

JOB SHEET #1 — REMOVE AND REPLACE A TRACK

A. Tools and materials

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Basic hand tools
4. Safety stand
5. New track as required
7. Safety glasses

B. Routine #1 — Removing the track

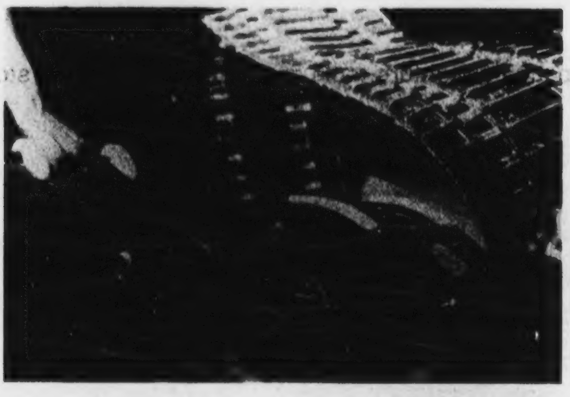
1. Put on safety glasses.
2. Raise and support the rear end of the snowmobile.
3. Remove the link springs from the link plates.
4. Loosen track tension by loosening the jam nuts of the adjustment bolts.
5. Remove the link plates from the frame of the snowmobile.
6. Using caution, lower the rear axle from the snowmobile. (Figure 1)

FIGURE 1

JOB SHEET #1

7. Remove the suspension assembly. (Figure 2)

FIGURE 2



8. Loosen the bearing support which holds the front axle to the frame.

9. Remove the front axle.

10. Record the direction of track travel to make certain reinstallation of the track is correct.

11. Remove the track from the snowmobile.

☐ Have your instructor check your work

C. Routine #2 — Replacing the track

1. Put on safety glasses

2. Insert the new track into the snowmobile frame.

   (NOTE: Working with a co-worker makes this routine easier and safer.)

3. Insert the front axle into the frame.

4. Secure the front axle into the frame.

5. Replace and secure the suspension assembly.

6. Install the rear axle and hook up the rear link plates.

JOB SHEET #1

7. Install all seals to the front and rear axles.

8. Tighten the track tension and check for alignment. (Refer to Job Sheet #2.)

☐ Have your instructor check your work.

9. Clean up area and return tools and materials to proper storage.

TRACKS
UNIT IX

JOB SHEET #2 — ADJUST TRACK TENSION AND ALIGNMENT

A. Tools and materials

1. Snowmobile as selected by instructor
2. Appropriate safety manual
3. Basic hand tools
4. Safety stand
5. Measuring tape
6. Safety glasses

B. Routine #1 — Adjusting tension

1. Put on safety glasses.
2. Make certain the ignition switch is in the "off" position.
3. Raise the snowmobile off the floor, and support it on a safety stand.
4. Use moderate pressure to press the track down at mid-span.
5. Measure the distance between the bottom of the wear strip of the slide rail and the inside surface of the track. (Figure 1)

FIGURE 1

JOB SHEET #2

6. Check repair manual to determine if tension is within specifications.

7. Correct tension by loosening or tightening the adjuster bolts located on the inner side of the rear idler wheels. (Figure 2)

FIGURE 2

C. Routine #2 — Adjusting alignment

(CAUTION: Before checking track alignment, always check the track to see that it is free of any rocks or other particles which could be thrown off the track while it is rotating. Also, make certain the tips of the skis are positioned against a wall or similar object.)

1. Raise the snowmobile off the ground onto a safety stand.

   (CAUTION: Make sure no one is in front of or behind the sled before you complete the following steps.)

2. Start the engine and gradually accelerate the track a few revolutions.

3. Turn the engine off and allow the track to stop on its own.

4. Inspect the distance between the track edge and the link plates, and inspect the idler wheels and their relationship with the track's inner drive lugs; all distances should be equal.

   a. If alignment is not indicated, loosen the adjustment bolt jam nuts on the opposite side of the misalignment and tighten the adjustment bolt jam nuts on the misaligned side.

JOB SHEET #2

b. Again, start engine and rotate the track a few times, then stop the engine and allow it to stop without braking.

c. If alignment is correct, then check the track tension again, making tension adjustment if necessary, tighten adjuster bolt jam nuts.

☐ Have your instructor check your work.

5. Clean up area and return tools and materials to proper storage.

(NOTE: On a properly tensioned track, the track should be able to be rotated by hand. If the track can not be moved by hand, the tension is too tight or other drive components are not functioning properly.)

TRACKS
UNIT IX

JOB SHEET #3 — SINGE A TRACK

A. Tools and materials

1. Snowmobile as selected by instructor
2. Basic hand tools
3. Small propane torch and lighter
4. Safety stand
5. Heavy wet rag
6. Safety glasses

B. Procedure

1. Put on safety glasses.
2. Support the snowmobile by placing it on the safety stand.
3. Make certain the engine is not running, ignition is off, and that there are no flammable substances on the snowmobile or in the area.
4. Light the torch.
5. Burn frayed edges off, and be sure to keep the flame moving as much as possible to avoid damaging the rubber base of the track.
6. Use the wet rag to put out any track fires.
7. Make certain both sides of the track are singed as needed.
8. Reinspect for overlooked frayed edges.

☐ Have your instructor check your work.

9. Clean up area and return tools and materials to proper storage.

TRACKS
UNIT IX

JOB SHEET #4 — REPLACE TRACK GUIDE CLIPS

A. Tools and materials

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Track guide clips (or inserts)
4. Track insert tool (if applicable)
5. Two medium-size hammers
6. Adjustable locking pliers (vise grip)
7. Basic hand tools
8. Drill and steel bit
9. Safety glasses

B. Procedure

1. Put on safety glasses.
2. Loosen the track tension on the snowmobile.
3. Tilt the snowmobile on its side, placing it on a piece of cardboard to protect it from scratches or scuffing.
4. Locate all guide clips or inserts that are severely worn and note if any are missing.
5. Remove worn clips by drilling a series of indentations across each clip or grinding an indentation with a die grinder, and splitting the clips open with a hammer and chisel.

   (NOTE: There is no need to drill all the way through the clip: short holes will be sufficient to cause the clips to split.)
6. Compress new clips onto the track with the manufacture's special installation tool.

   (NOTE: Installation of new clips without the use of the manufacturer's recommended tool is not advised, as proper installation can not be achieved without it.
7. Rotate the track until all worn or missing clips have been replaced.

   (NOTE: If there is inadequate clearance to perform the above procedure with the suspension in place, the suspension should be removed.)

JOB SHEET #4

☐ Have your instructor check your work.

8. Readjust tension and align the track as previously outlined.

9. Clean up area and return tools and equipment to proper storage.

TRACKS
UNIT IX

NAME ____________________

TEST

1. Match terms related to tracks with their correct definitions

_____a. A rubberized belt with metal guide clips that transfer power from the axle sprockets to the entire belt which has exterior molded cleats to grab the snow and help keep a snowmobile moving

_____b. Metal clips inserted into the track to eliminate wear to the track by the sprockets

_____c. The tightness or looseness of the track

_____d. Equal track distance on both sides of the snowmobile frame

_____e. Nylon cords molded into the track to give it strength

_____f. Burning or melting frayed ends of track which occurs as the track begins to wear

_____g. Steel rods molded into the track to make it rigid and give the track strength

1. Track tension
2. Cords
3. Rods
4. Singeing
5. Track
6. Track alignment
7. Guide clips

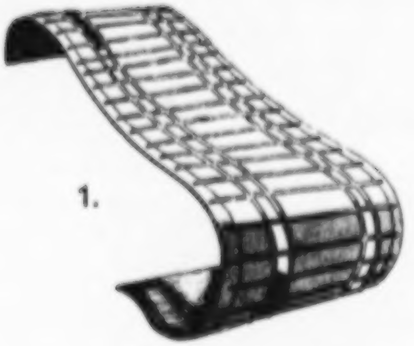
TEST

2. Identify types of tracks by inserting the number of the track type in the appropriate blank.

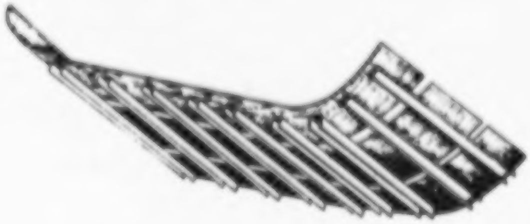
   _____a. Internal drive track

   _____b. Rubber track with steel or fiberglass rods molded into it

   _____c. Cleated track found only on older model snowmobiles



1.



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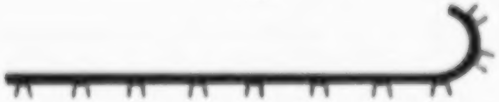
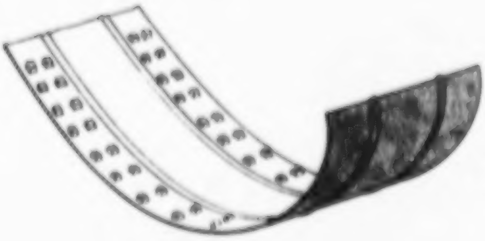
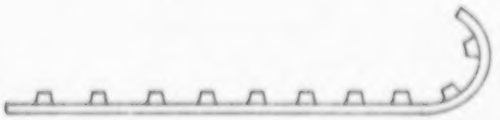




3.



TEST

3. Select true statements concerning causes of track failure by placing an "X" in front of each true statement.

_____a. The track not being aligned for a long period of time is a common cause of track failure.

_____b. Cuts caused by running over sharp objects are the least frequent cause of track failure.

_____c. Broken cleats, on older models, if not repaired, can damage the track.

_____d. Worn sprockets on the axle can damage the track.

_____e. Normal wear will eventually require track replacement.

_____f. Tension on the track must be correct or abnormal wear can occur.

_____g. Track may be installed so that it rotates in either direction.

4. Complete statements concerning track tension and alignment by circling the word(s) that best completes each statement.

a. Track tension and alignment (**are, are not**) interrelated.

b. Always establish the correct tension (**before, after**) checking and adjusting alignment.

c. To inspect track tension, slide a gloved hand along the inside of the chassis tunnel and vigorously push the underside of the track up and down; the track (**must, must not**) hit the top of the tunnel or slap against the skid frame.

d. Proper track alignment occurs when the rear idler wheels are equal distance from the inner drive lugs of the track or the (**outside, inside**) edge of the track.

5. Arrange in order the steps in track tension inspection by placing the correct sequence number in the appropriate blank.

_____a. Measure for a distance of about ½" to 1" between the slide rail and the track.

_____b. Apply about 5 to 10 pounds of pull downward at the center of the track.

_____c. If the slide rail to track distance is more or less than manufacturer's specification, the track should be adjusted.

_____d. Raise the rear of the sled safely off the ground.

TEST

6. Complete statements concerning singeing a track by inserting the word(s) that best completes each statement.

   a. Singeing the track is a technique that ______________ frayed track cords caused by track wear.

   b. Frayed cords left on a track will accelerate more track wear, so singeing will help ______________ track life and improve the appearance of the sled.

   c. Singeing is best accomplished by burning off frayed track with a propane torch, but ______________ must be a prime concern during the procedure.

   d. Rules for singeing a track are:

      1) Make sure the area is free of flammable materials and that there is a ______________ ______________ handy.

      2) Make sure the engine is stopped and the ignition ______________.

      3) Keep a heavy, wet rag for ______________ track areas after they have been singed.

      4) Be careful not to overheat the track edges and damage the track's ______________ base.

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

7. Solve problems related to track maintenance. (Assignment Sheet #1)

8. Demonstrate the ability to:

   a. Remove and replace a track. (Job Sheet #1)

   b. Adjust track tension and alignment. (Job Sheet #2)

   c. Singe a track. (Job Sheet #3)

   d. Replace track guide clips. (Job Sheet #4)

TRACKS
UNIT IX

ANSWERS TO TEST

1. a. 5 e. 2
   b. 7 f. 4
   c. 1 g. 3
   d. 6

2. a. 3
   b. 1
   c. 2

3. a, c, d, e, f

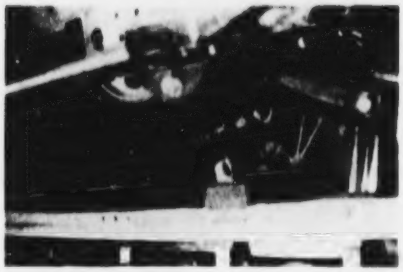
4. a. Are
   b. Before
   c. Must not
   d. Outside

5. a. 3
   b. 2
   c. 4
   d. 1

6. a. Burns
   b. Increase
   c. Safety
   d. 1) Fire extinguisher
      2) Off
      3) Quinching
      4) Rubber

7. Evaluated to the satisfaction of the instructor

8. Performance skills evaluated according to procedures written in the job sheets



SHOCK ABSORBERS
UNIT X

UNIT OBJECTIVE

After completion of this unit, the student should be able to discuss the types of shock absorbers and guidelines for shock absorber inspection. The student should also be able to remove and replace a shock and adjust spring preload. These competencies will be evidenced by correctly performing the procedures outlined in the assignment and job sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student will be able to:

1. Match terms related to shock absorbers with their correct definitions.
2. Identify the location of shock absorbers.
3. Select true statements concerning the purposes of shock absorbers.
4. Complete statements concerning types of shock absorbers.
5. Complete statements concerning shock absorber inspection.
6. Solve problems related to snowmobile shock absorbers. (Assignment Sheet #1)
7. Demonstrate the ability to:
    a. Remove and replace an oil-filled shock absorber. (Job Sheet #1)
    b. Adjust spring preload. (Job Sheet #2)

SHOCK ABSORBERS
UNIT X

SUGGESTED ACTIVITIES

A. Provide students with objective sheet.

B. Provide students with information sheet.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Demonstrate and discuss the procedures outlined in the job sheets.

G. Visit a local Yamaha dealership to inspect the struts on the front suspension of Yamaha snowmobiles.

H. Discuss nitrogen-filled shocks and special safety requirements for their replacement.

I. Give test.

CONTENTS OF THIS UNIT

A. Objective sheet

B. Information sheet

C. Transparency masters

    1. TM 1 — Front Shock Absorbers

    2. TM 2 — Rear Shock Absorbers

D. Assignment Sheet #1 — Solve Problems Related to Snowmobile Shock Absorbers

E. Answers to assignment sheet

F. Job sheets

    1. Job Sheet #1 — Remove and Replace a Shock Absorber

    2. Job Sheet #2 — Adjust Spring Preload

G. Test

H. Answers to test

REFERENCES USED IN DEVELOPING THIS UNIT

A. *Snowmobile Repair.* Stillwater, OK 74074: Mid-America Vocational Curriculum Consortium, 1976.

B. *1986 Yamaha Snowmobile Mechanics Guide.* Cypress, CA: Yamaha Motor Corporation, U.S.A., 1985.

C. *Arctic Cat Service Manual No. 2254-302.* Thief River Falls, MN 56701: ARCTCO, Inc., 1984.

D. *Kawasaki Drifter Snowmobile Shop Manual.* Santa Ana, CA 92799-5252: Kawasaki Motors Corp., U.S.A., 1980.

E. *Kawasaki Parts Catalog SB340-A2, SB440-A5.* Santa Ana, CA 92799-5252: Kawasaki Motors Corp., U.S.A., 1980.

SHOCK ABSORBERS
UNIT X

INFORMATION SHEET

I. **Terms and definitions**

A. Shock absorber — A component of a snowmobile suspension system designed to absorb the impact from bumps and to help stabilize the moving chassis

B. Oil-filled shock absorber — A shock absorber which uses oil and a valve system to dampen shock absorber piston movement and absorb shock

C. Gas-filled shock absorber — A shock absorber which uses nitrogen gas and a valve system to dampen piston movement and absorb shock

D. Strut — A large cylinder mechanism which serves as an entire suspension assembly to support the snowmobile chassis and absorb shocks

E. Preload — The amount of tension built into a shock absorber which establishes the compression and rebound characteristics

F. Compression — The amount of pressure exerted on a shock as it absorbs the force of impact

G. Rebound — The amount of pressure the shock absorber gives back as the valve inside the shock reacts to compression

H. Dual-acting valving — A shock absorber which has a valve action to accept compression and return rebound pressure

II. **Location of shock absorbers**

A. Front shock absorbers are part of the front suspension system and are attached to the ski skeg and to the ski. (Transparency 1)

B. The front suspension may be a strut-type suspension system.

C. Rear shock absorbers are part of the rear suspension system which supports the entire chassis and are usually attached to cross shafts of the slide rail suspension system. (Transparency 2)

III. **Purposes of shock absorbers**

A. Rear shock absorbers stiffen the ride within a slide rail suspension system.

B. Front shock absorbers apply down pressure to the ski for better steering control.

INFORMATION SHEET

C. All shock absorbers serve to protect the operator and the chassis by absorbing impact energy which may be strong enough to damage components of the snowmobile.

IV. **Types of shock absorbers**

A. Most snowmobiles use non-adjustable, oil-filled shock absorbers in which preload is already set.

B. Some snowmobiles which operate on a variety of surface conditions use adjustable oil-filled shock absorbers in which the preload can be set by the operator to contend with changing riding conditions.

C. As part of the rear suspension, some high performance snowmobiles use gas-filled shock absorbers which withstand greater stress and shock.

D. Yamaha first introduced the front strut suspension, and many of their models use the strut as the shock absorbing mechanism.

V. **Shock absorber inspection**

A. Since shock absorbers require no maintenance, they do require inspection from time to time to see if they need to be replaced.

B. Anytime regular maintenance is performed on a sled, the shocks should be inspected.

C. If the chassis feels springy when it is bounced up and down, the shock absorbers probably need to be replaced.

D. When there is evidence that oil is leaking from a shock absorber, it should be replaced.

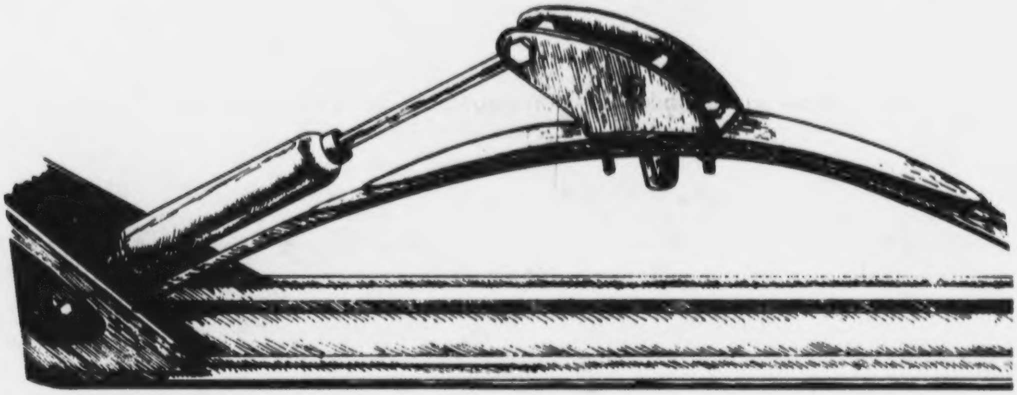
E. Shock mounting bushings should be checked for wear and replaced as required.

F. Shock absorbers filled with nitrogen gas sometimes have to have holes drilled in them to release pressure, and require special handling.

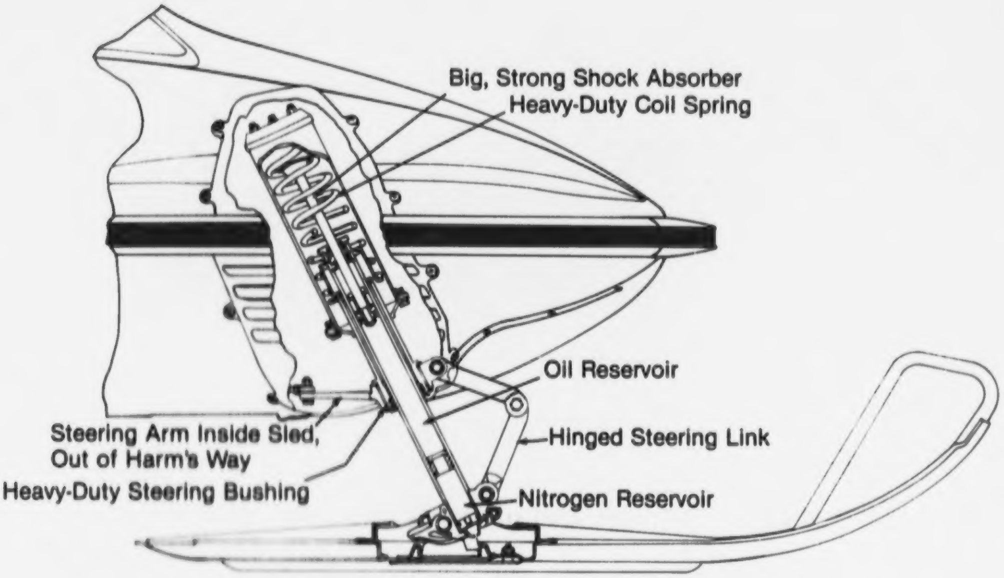
(CAUTION: Nitrogen filled shocks do have a potential to explode.)

1. Always wear safety glasses when drilling on nitrogen-filled shocks.
2. Put a shop towel close to the drill to catch bits of steel that might be blown out by escaping gas.

Front Shock Absorbers



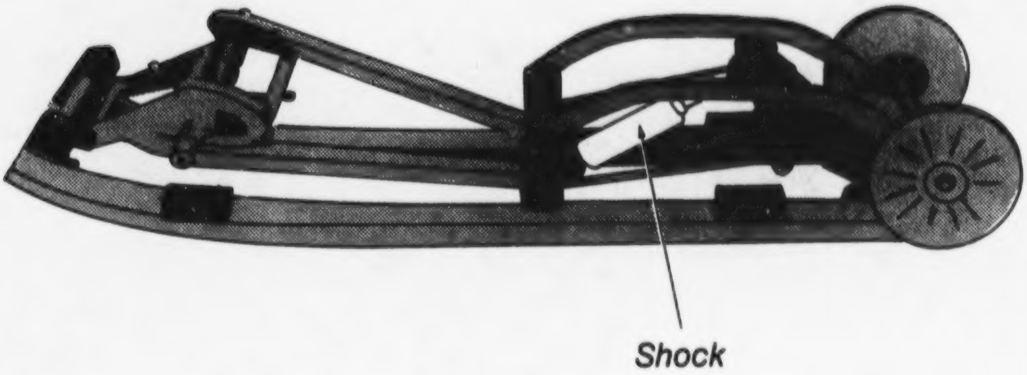
Traditional


Big, Strong Shock Absorber
Heavy-Duty Coil Spring
Oil Reservoir
Steering Arm Inside Sled, Out of Harm's Way
Hinged Steering Link
Heavy-Duty Steering Bushing
Nitrogen Reservoir

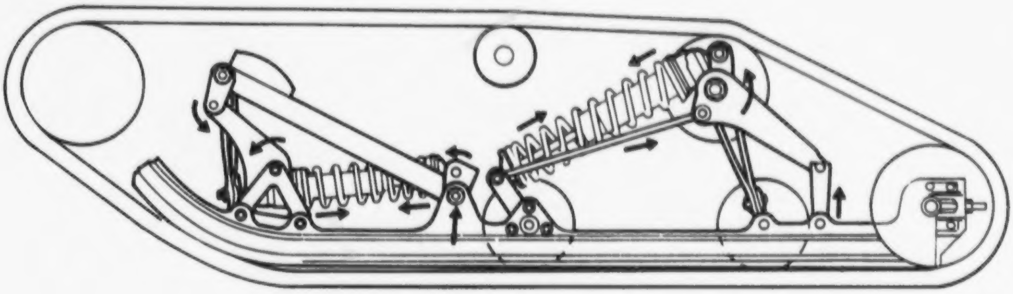
Yamaha Telescopic Strut Suspension

Courtesy Yamaha Motor Corporation, U.S.A.

Rear Shock Absorbers



Traditional



Yamaha Progressive Link Rear Suspension

Courtesy Yamaha Motor Corporation, U.S.A.

SHOCK ABSORBERS
UNIT X

ASSIGNMENT SHEET #1 — SOLVE PROBLEMS RELATED TO SNOWMOBILE SHOCK ABSORBERS

Directions: Read the following problems carefully and respond as directed.

A. Your racing snowmobile has nitrogen-filled gas shock absorbers. Lately the performance of the snowmobile has felt spongy or springy and you think the shock absorber may need to be replaced. What procedures should you take in replacing one or more of the shocks?

____

____

B. While listening to a lecture by your instructor about shock absorbers, you hear him mention dual-action valving. What does he mean?

____

____

C. You overhear two friends talking about their snowmobiles. One of them argues that his is a better racing machine because his snowmobile has struts on the rear suspension. What is it about his statement that leads you to believe he is not correct?

____

____

D. Why should you wear safety glasses when replacing a gas-filled shock absorber?

____

____

SHOCK ABSORBERS
UNIT X

ANSWERS TO ASSIGNMENT SHEET

A. First, because of the potential the shock has of exploding, always consult the manufacturer's repair manual and use safety glasses. It may be necessary to drill a hole in the shock absorber to release the gas. From that point, the procedure for removal and installation of a new shock is identical to the procedure for installing standard oil-filled shocks.

B. Dual-action valving refers to the shock absorber having two mechanical operations. The first is compression where the valve moves inward with resistance. The second is rebound where the valve moves back out with resistance.

C. Yamaha does produce snowmobiles for racing that have strut suspensions, but the struts are located on the front to support and stabilize the skis and steering, not the rear.

D. Manufacturer's repair manuals will occasionally recommend that the nitrogen-filled shock absorbers be punctured using a drill, an operation aimed at releasing pressure inside the shock. That procedure can often spew out dirt particles which can strike the face and eyes. Safety glasses protect the eyes in such cases, and a shop towel placed over the opening will provide added protection.

SHOCK ABSORBERS
UNIT X

JOB SHEET #1 — REMOVE AND REPLACE AN OIL-FILLED SHOCK ABSORBER

A. Tools and materials

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Side cutters
4. Pin punch
5. Hammer
6. Replacement cotter pins
7. Straightedge
8. Safety glasses

B. Procedure

1. Put on safety glasses
2. Remove the mounting bolts and lock nuts that hold the shock absorber in place, or if it's an older sled, remove the cotter pins (Figure 1)

FIGURE 1

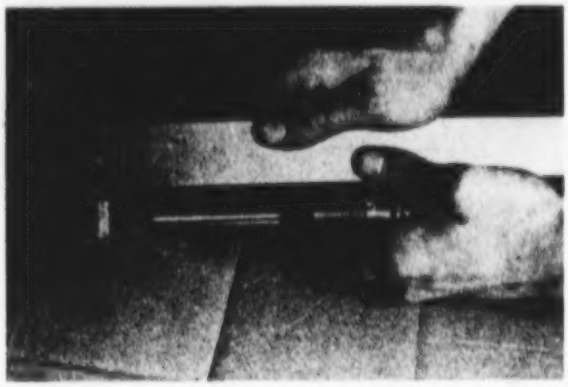
JOB SHEET #1

3. Remove the clevis pins from the shock mountings (Figure 2)

FIGURE 2

4. Use a straightedge to check the shock for a bent or binding shock shaft (Figure 3)

FIGURE 3



JOB SHEET #1

5. Press down firmly on the shock shaft to check for proper compression and rebound action, and watch carefully for any sign of oil leaks (Figure 4)

FIGURE 4

6. Put the clevis pin back through the bushings and work it back and forth to check for excess bushing play (Figure 5)

FIGURE 5

7. Install a new shock absorber or replace the old shock absorber by reversing the disassembly procedure, and be sure to use new cotter pins

☐ Have your instructor check your work

8. Clean up area and return tool and materials to proper storage

SHOCK ABSORBERS
UNIT X

JOB SHEET #2 — ADJUST SPRING PRELOAD

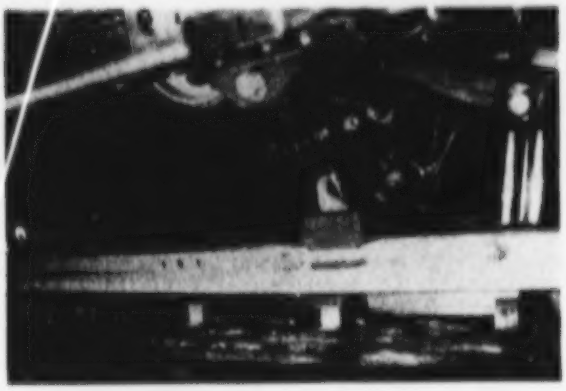
A. Tools and materials

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Basic hand tools
4. Special adjustment tools as required
5. Safety glasses

B. Routine #1 — Adjusting rear spring preload

1. Put on safety glasses.
2. Read the service manual to determine the type of adjustment required.
3. Rotate the preload adjustment cam at the end of the shock clockwise or counterclockwise as required to make the suspension stiffer or softer (Figure 1)

FIGURE 1



4. Adjust the second shock if it is a dual-shock suspension

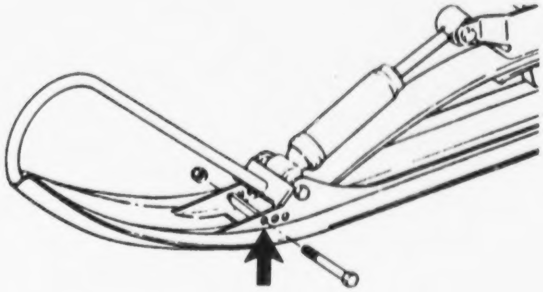
☐ Have your instructor check your work

JOB SHEET #2

C. Routine #2 — Adjusting front spring preload

1. Put on safety glasses
2. Remove the nut from the spring mounting bolt, and remove the bolt (Figure 2)

FIGURE 2



Courtesy Kawasaki Motors Corp., U.S.A.

3. Make desired adjustment according to the following, and refer to Figure 2 as needed:

   a. To reduce spring preload, replace the bolt in the rear hole, and this will result in greater spring travel and a softer ride; this setting is good for deep snow operation or slow speed trail riding

   b. To increase spring preload, replace the bolt in the front hole, and this fill result in lesser spring travel and a stiffer ride; this setting is good for maximum stability during high speed operation

   c. To maintain a spring preload for general use, replace the bolt in the center hole

   (NOTE: Be sure to check your service manual, the preload adjustment varies from sled to sled and model to model.)

4. Be sure that the front spring preload is set the same on both skis

☐ Have your instructor check your work

5. Clean up area and return tools and equipment to proper storage

SHOCK ABSORBERS
UNIT X

NAME ____________________

TEST

1. Match terms related to shock absorbers with their correct definitions.

_____a. A component of a snowmobile suspension system designed to absorb the impact from bumps and to help stabilize the moving chassis

_____b. A shock absorber which uses oil and a valve system to dampen shock absorber piston movement and absorb shock

_____c. A shock absorber which uses nitrogen gas and a valve system to dampen piston movement and absorb shock

_____d. A large cylinder mechanism which serves as an entire suspension assembly to support the snowmobile chassis and absorb shocks

_____e. The amount of tension built into a shock absorber which establishes the compression and rebound characteristics

_____f. The amount of pressure exerted on a shock as it absorbs the force of impact

_____g. The amount of pressure the shock absorber gives back as the valve inside the shock reacts to compression

_____h. A shock absorber which has a valve action to accept compression and return rebound pressure

1. Strut
2. Compression
3. Shock absorber
4. Gas-filled shock absorber
5. Dual-acting valving
6. Preload
7. Rebound
8. Oil-filled shock absorber

TEST

2. Complete statements concerning location of shock absorbers by inserting the word(s) that best completes each statement.

   a. Front shock absorbers are part of the front suspension system and are attached to the ski ____________ and to the ski.

   b. The front suspension may be a ____________ ____________ suspension system.

   c. Rear shock absorbers are part of the rear suspension system which supports the entire chassis and are usually attached to ____________ ____________ of the slide rail suspension system.

3. Select true statements concerning the purposes of shock absorbers by placing an "X" beside each statement that is true.

   _____a. Rear shock absorbers soften the ride within a slide rail suspension system.

   _____b. Front shock absorbers apply down pressure to the ski for better steering control.

   _____c. All shock absorbers serve to protect the operator and the chassis by absorbing impact energy which may be strong enough to damage components of the snowmobile.

4. Complete statements concerning the types of shock absorbers by inserting the word(s) that best completes each statement.

   a. Most snowmobiles use non-adjustable, oil-filled shock absorbers in which ____________ is already set.

   b. Some snowmobiles which operate on a variety of surface conditions use adjustable ____________ shock absorbers in which the preload can be set by the operator to contend with changing riding conditions.

   c. As part of the ____________ suspension, some high performance snowmobiles use gas-filled shock absorbers which withstand greater stress and shock.

   d. ____________ first introduced the front strut suspension, and many of their models use the strut as the shock absorbing mechanism.

5. Complete statements concerning shock absorber inspection by inserting the word(s) that best completes each statement.

   a. Since shock absorbers require no maintenance, they do require ____________ from time to time to see if they need to be replaced.

   b. Anytime regular ____________ is performed on a sled, the shocks should be inspected.

TEST

c. If the chassis feels ____________ when it is bounced up and down, the shock absorbers probably need to be replaced.

d. When there is evidence that ____________ is leaking from a shock absorber, it should be replaced.

e. Shock ____________ ____________ should be checked for wear and replaced as required.

f. Shock absorbers filled with nitrogen gas sometimes have to have holes drilled in them to release pressure, and require special handling.

   1) Always wear ____________ ____________ when drilling on nitrogen-filled shocks.

   2) Put a shop towel close to the drill to catch bits of steel that might be blown out by ____________ gas.

(NOTE: If the following activities have not been completed prior to the test, ask your instructor when they should be completed.)

6. Solve problems related to snowmobile shock absorbers. (Assignment Sheet #1)

7. Demonstrate the ability to:

   a. Remove and replace an oil-filled shock absorber. (Job Sheet #1)

   b. Adjust spring preload. (Job Sheet #2)

SHOCK ABSORBERS
UNIT X

ANSWERS TO TEST

1. a. 3
   b. 8
   c. 4
   d. 1
   e. 6
   f. 2
   g. 7
   h. 5

2. a. Skeg
   b. Strut-type
   c. Cross shafts

3. b, c

4. a. Preload
   b. Oil-filled
   c. Rear
   d. Yamaha

5. a. Inspection
   b. Maintenance
   c. Springy
   d. Oil
   e. Mounting bushings
   f. 1) Safety glasses
      2) Escaping

6. Evaluated to the satisfaction of the instructor

7. Performance skills evaluated according to procedures written in the job sheets.

BRAKES
UNIT XI

UNIT OBJECTIVE

After completion of this unit, the student should be able to discuss the types of brake systems found on modern snowmobiles and identify the components of typical brake systems. The student should also be able to disassemble and reassemble a disc brake, adjust a disc brake, and bleed a hydraulic brake unit. These competencies will be evidenced by correctly performing the procedures outlined in the assignment and job sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student will be able to:

1. Match terms related to brakes with their correct definitions.
2. Identify parts of a typical disc brake unit.
3. Identify parts of a typical hydraulic brake unit.
4. Select true statements concerning types of snowmobile brakes.
5. Complete statements concerning maintenance.
6. Select true statements concerning brake fluid.
7. Solve problems related to maintenance of brake systems. (Assignment Sheet #1)
8. Demonstrate the ability to:
    a. Disassemble and reassemble a disc brake. (Job Sheet #1)
    b. Adjust a disc brake. (Job Sheet #2)
    c. Bleed a hydraulic brake unit. (Job Sheet #3)

BRAKES
UNIT XI

SUGGESTED ACTIVITIES

A. Provide students with objective sheet.

B. Provide students with information sheet.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Demonstrate and discuss the procedures outlined in the job sheets.

G. Impress upon students the importance of selecting proper brake fluid and the equal importance of handling brake fluid with care.

H. Give test.

CONTENTS OF THIS UNIT

A. Objective sheet

B. Information sheet

C. Transparency masters

   1. TM 1 — Manual Disc Brake

   2. TM 2 — Hydraulic Disc Brake

D. Assignment Sheet #1 — Solve Problems Related to Maintenance of Brake Systems

E. Answers to assignment sheet

F. Job sheets

   1. Job Sheet #1 — Disassemble and Reassemble a Disc Brake

   2. Job Sheet #2 — Adjust a Disc Brake

   3. Job Sheet #3 — Bleed a Hydraulic Brake Unit

G. Test

H. Answers to test

REFERENCES USED IN DEVELOPING THIS UNIT

A. *Snowmobile Repair.* Stillwater, OK 74074: Mid-America Vocational Curriculum Consortium, 1976.

B. *Chilton's Snowmobiles Repair & Tune-Up Guide,* Second Edition. Radnor, PA: Chilton Book Co., 1975.

C. *1980 Bombardier Snowmobiles Shop Manual.* Valcourt, Quebec, Canada: Bombardier, Ltd. 1980.

D. *1978 Polaris Shop Manual.* Roseau, MN: Polaris/Textron, 1978.

E. *Arctic Cat Service Manual No. 2254-302.* Thief River Falls, MN 56701: ARCTCO, Inc. 1984.

F. *Kawasaki Drifter Snowmobile Shop Manual.* Santa Ana, CA 92799-5252: Kawasaki Motors Corp., U.S.A., 1980.

G. *Kawasaki Parts Catalog SB340-A2, SB440-A5.* Santa Ana, CA 92799-5252: Kawasaki Motors Corp., U.S.A., 1980.

BRAKES
UNIT XI

INFORMATION SHEET

I. **Terms and definitions**

A. Disc brakes — A brake system which uses calipers, fiber pads, and a disc to stop movement of the track

B. Hydraulic brakes — A brake system which uses hydraulic fluid to apply braking force

C. Pad — The friction material forced against the disc to produce braking friction

D. Calipers — In disc brake systems, an assembly which holds the pads and applies mechanical or hydraulic pressure to the brake disc

E. Brake cable — A cable which transfers braking action from a lever on the handlebar to the brake

F. Cable housing — The housing used to guide the brake cable so friction or sticking of the cable will be eliminated

G. Self-adjusting brake caliper — A ratcheting-type gear found on disc brakes; used to maintain proper clearance between the pad and the disc

H. Hydraulic calipers — On hydraulic brake systems, the assembly which houses pads, hydraulic piston, and bleeder valve

I. Master cylinder — Attached to the handlebars of a hydraulic brake system, and used as a reservoir for the brake fluid

J. Plunger — On hydraulic brake systems, the mechanism which forces hydraulic fluid from the master cylinder through the hose to the calipers to supply pressure to the pads

K. Hand lever — On hydraulic brake systems, it is used to actuate the plunger, forcing fluid to the calipers

L. Bleeder valve — A small outlet in the caliper used to release air trapped in the system

M. Brake fluid — Hydraulic fluid used to transfer pressure from the master cylinder to the calipers

INFORMATION SHEET

II. **Parts of a typical disc brake unit** (Transparency 1)

  A. Brake disc plate

  B. Pads

  C. Caliper

  D. Plunger

  E. Actuator lever

  F. Brake support bracket

  G. Cable and housing

III. **Parts of a typical hydraulic brake unit** (Transparency 2)

  A. Fluid reservoir

  B. Master cylinder

  C. Master cylinder piston

  D. Return spring

  E. Hand lever

  F. Brake support bracket

  G. Brake disc plate

  H. Caliper

  I. Pads

  J. Piston

  K. Bleeder valve (screw)

IV. **Types of snowmobile brakes**

  A. Manual disc brakes use discs attached directly or indirectly to the driven clutch to stop movement of the track, and are manually adjusted. (Transparency 1)

  B. Self-adjusting cable-operated disc brakes are similar to the manual disc brakes except the system uses ratcheting-type gear to maintain proper clearance between the pad and the disc as the pad wears.

  C. Hydraulic brake systems also use pads but the pads are activated by hydraulic pressure. The hydraulic pressure is developed by movement of the brake hand lever which pressurizes hydraulic fluid in the master cylinder. The hydraulic pressure is transferred via the brake tubing to the caliper housing, causing the caliper piston to move and the pads to contact the disk.

INFORMATION SHEET

V. Maintenance

A. The most common maintenance which must be performed on both disc and hydraulic brake systems is brake adjustment, primarily adjusting the brake cables and the pad to disc clearance.

B. On most disc brake systems, the brake should be fully applied when the brake control lever on the handle bars is depressed about one-half inch.

C. Self-adjusting disc brakes use a ratchet mechanism to maintain proper pad clearance.

(NOTE: The ratchet mechanism is activated by normal braking operation, and the only other adjustment usually needed is cable free play.)

D. A spongy action on the hand brake lever on hydraulic brakes may indicate air in the system which requires that the system be bled of all trapped air.

E. During routine maintenance inspections, the brake system should be inspected for worn brake pads which must be replaced if less than 1/8" remains (or as manufacturer specifies).

F. During disassembly of the brake system it should be a routine operation to clean all metal components using a general purpose solvent and a dry clean cloth.

G. When hydraulic brake fluid is not reaching the plunger mechanism to activate the brakes, it may be caused by a malfunctioning master cylinder or an air lock, if the system has been recently drained.

H. Never allow oil, grease, or brake fluid to contaminate the pads.

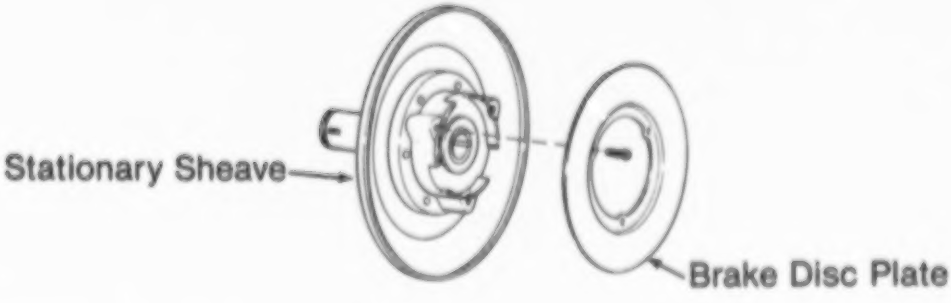
VI. Brake fluid

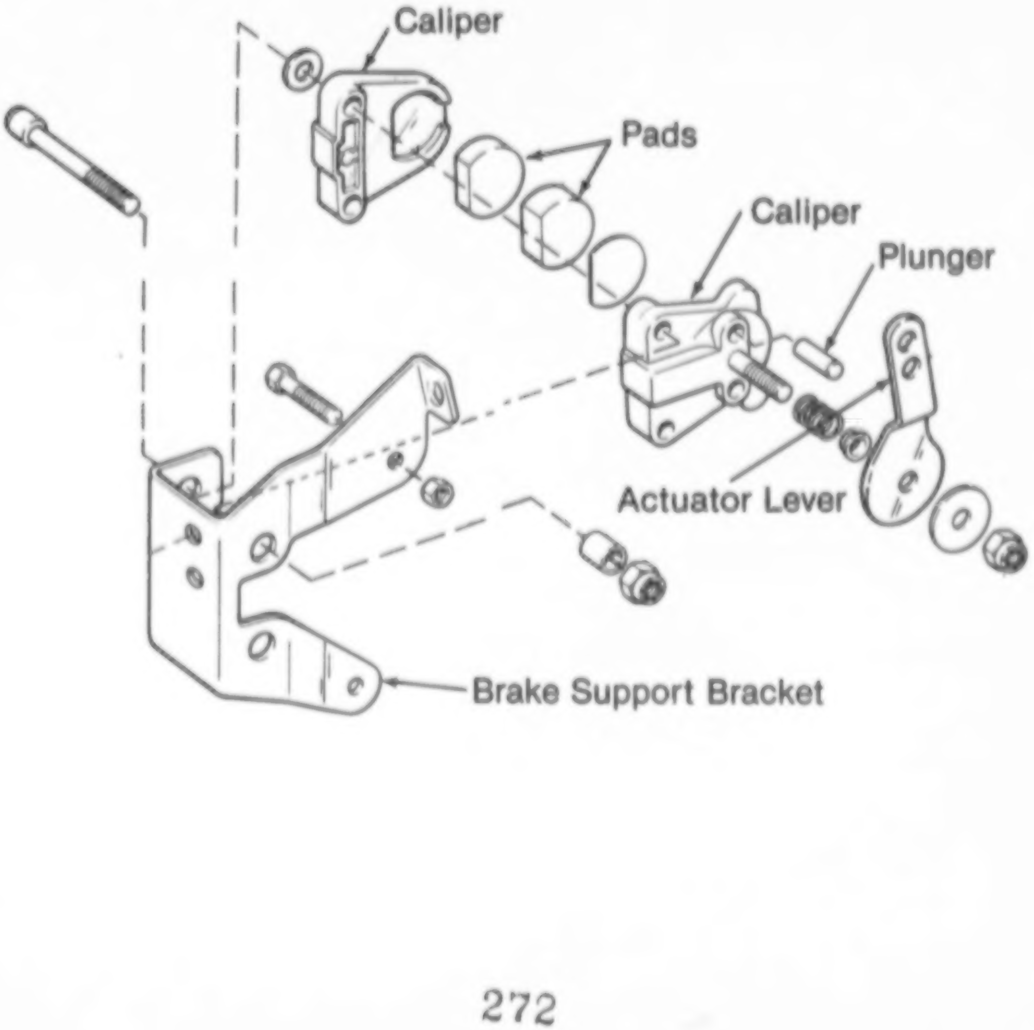
A. Before putting brake fluid into a system, always check the service manual for the type of fluid the system requires, and use only that fluid.

B. Brake fluid will damage a painted surface almost instantly, and painted surfaces on a snowmobile should be protected with nonabsorbent coverings.

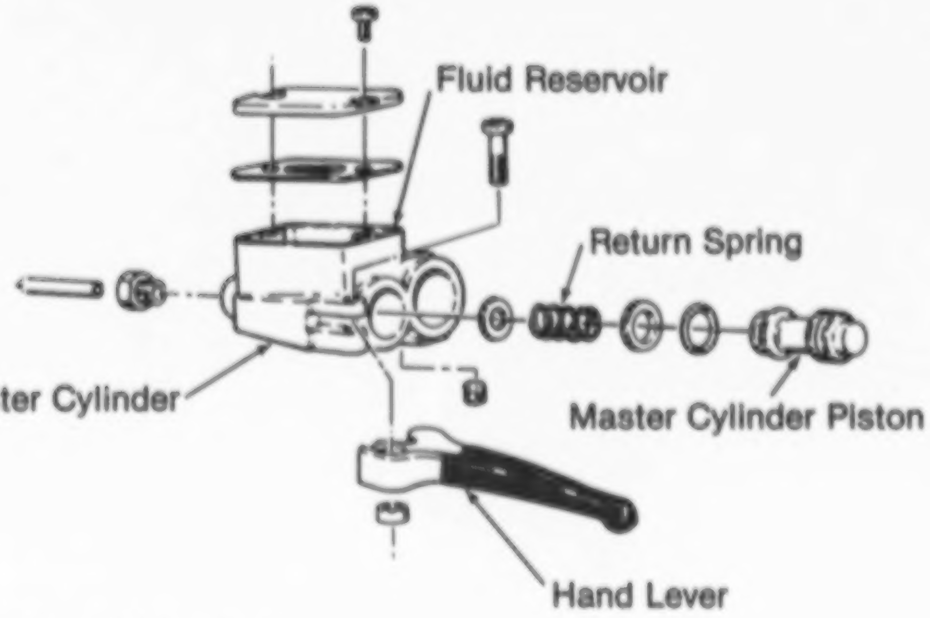
C. Old brake fluids should never be reused and should be disposed of in an approved manner.

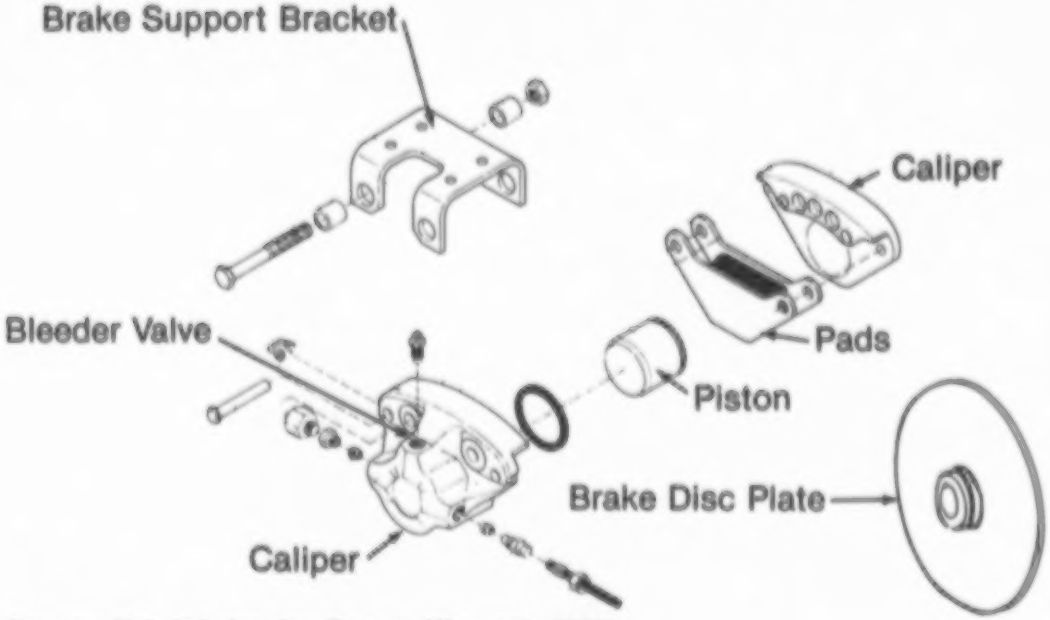
Manual Disc Brake


Stationary Sheave
Brake Disc Plate


Caliper
Pads
Caliper
Plunger
Actuator Lever
Brake Support Bracket

Hydraulic Disc Brake


Fluid Reservoir
Return Spring
Master Cylinder
Master Cylinder Piston
Hand Lever


Brake Support Bracket
Caliper
Pads
Bleeder Valve
Piston
Brake Disc Plate
Caliper

Courtesy Polaris Industries, Roseau, Minnesota 56751

BRAKES
UNIT XI

ASSIGNMENT SHEET #1 — SOLVE PROBLEMS RELATED TO MAINTENANCE OF BRAKE SYSTEMS

Directions: Read the following problems carefully and respond as directed.

A. A friend complains to you that there is too much play in the hand lever of a manual disc brake unit. As you examine it and adjust the brakes you discover that the unit is already adjusted. Consequently, what might you expect to be the problem?

____

____

B. Another friend who owns a snowmobile with a hydraulic disc brake system complains to you that the hand lever feels "spongy." What would you suspect the trouble to be?

____

____

C. After inspecting a hydraulic brake system and bleeding it of air, the system functions well momentarily, but then the brakes fail to grab with any pressure. What might the problem be then?

____

____

D. In bleeding a hydraulic brake unit it is necessary that none of the fluid spill onto the snowmobile. Why?

____

____

BRAKES
UNIT XI

ANSWERS TO ASSIGNMENT SHEET

A. If the brakes are adjusted and there is still too much play in the system, the problem is probably that the disc brake pads are extensively worn and need to be replaced.

B. There is probably air in the hydraulic fluid and it will probably have to be bled out.

C. The brakes are probably not getting any or enough brake fluid because of low fluid level. It is possible that there may be a leak in the line or the master cylinder is malfunctioning and may need to be replaced.

D. The hydraulic brake fluid contains an element which will destroy paint.

BRAKES
UNIT XI

JOB SHEET #1 — DISASSEMBLE AND REASSEMBLE A DISC BRAKE

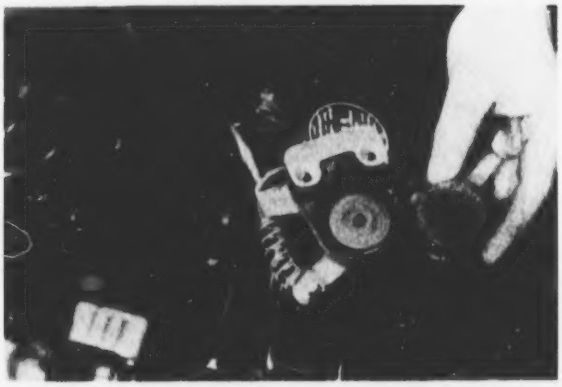
A. Tools and materials

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Basic hand tools
4. Solvent
5. Clean shop towels
6. Safety glasses

B. Routine #1 — Disassembling the brake

1. Put on safety glasses.
2. Remove the brake cable from the caliper lever.
3. Remove all pins, nuts or bolts from the mounting caliper to the snowmobile.
4. Loosen the tension on the caliper assembly from the snowmobile.
5. Remove the caliper assembly from the snowmobile.
6. Disassemble the caliper and remove the pads. (Figure 1)

FIGURE 1



JOB SHEET #1

7. Clean all metal parts with a general solvent and dry cloth, but keep solvent away from pad surfaces.

8. Inspect all parts for wear.

9. Replace parts excessively worn or damaged.

   (NOTE: Consult the service manual to determine if a part has excessive wear.)

C. Routine #2 — Reassembling the brake

1. Reverse procedure for disassembly.

2. Apply low temperature grease on threads and spring seat.

3. Tighten all nuts and bolts according to torque specifications in service manual.

4. Adjust the brake (refer to Job Sheet #2).

☐ Have your instructor check your work.

5. Clean up area and return tools and materials to proper storage.

BRAKES
UNIT XI

JOB SHEET #2 — ADJUST A DISC BRAKE

A. Tools and materials

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Basic hand tools
4. Safety glasses

B. Procedure

1. Put on safety glasses.
2. Apply pressure to the brake lever.

   (NOTE: If the handle moves freely for 1/2 to 3/4 of an inch without applying pressure to the disc brake, the brake must be adjusted.)

3. Make adjustment at the brake caliper assembly, if needed, by loosening the adjustor bolt jam nut and screwing the adjustor bolt in or out to obtain proper pad to disc clearance.

   (NOTE: Check manufacturer's specifications for clearance distance.)

4. Retighten the jam nut to proper torque specs.
5. Adjust brake lever travel (cable free play) to manufacturer's specifications by loosening the jam nut(s) and turn the cable adjustor in or out as required.
6. Retighten the jam nut(s).
7. Compress the hand lever and double check clearances and proper operation.
8. Clean up area and return tools and materials to proper storage.

BRAKES
UNIT XI

JOB SHEET #3 — BLEED A HYDRAULIC BRAKE UNIT

A. Tools and materials

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Hydraulic brake fluid
4. Small ignition wrench set
5. Clean shop towels
6. Clear plastic tube
7. Small container to catch brake fluid
8. Safety glasses

B. Procedure

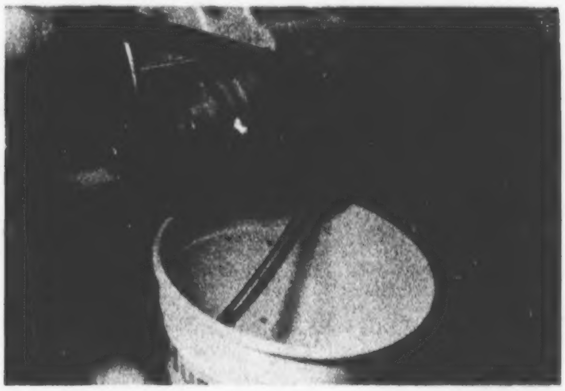
1. Put on safety glasses.
2. Check the fluid level in the master cylinder and fill if necessary, making certain that the reservoir is at its highest possible level.
3. Reinstall the master cylinder cap.
4. Locate the bleeder valve on the caliper assembly. (Figure 1)

FIGURE 1

JOB SHEET #3

5. Place one end of the clear plastic tube onto the bleeder valve and route the brake fluid safely away from any sled components into a catch pan. (Figure 2)

FIGURE 2



6. Pump the handle on the master cylinder and hold so that pressure remains applied.

7. Keep a constant pressure on the handle as you turn the bleeder valve to release air.

8. Close the bleeder valve as the brake lever reaches the end of its travel.

9. Release the brake lever.

10. Repeat pumping the brake lever and closing and opening the bleeder valve until there are no air bubbles present in the drain line.

11. Wipe up any brake fluid that might have spilled.

12. Check brake fluid level in master cylinder and top off with proper amount of brake fluid type specified by manufacturer.

☐ Have your instructor check your work.

13. Clean up area and return tools and materials to proper storage.

BRAKES
UNIT XI

NAME ______________________

TEST

1. Match terms related to brakes with their correct definitions.

_____a. A brake system which uses calipers, fiber pads, and a disc to stop movement of the track

_____b. A brake system which uses hydraulic fluid to apply braking force

_____c. The friction material forced against the disc to produce braking friction

_____d. In disc brake systems, an assembly which holds the pads and applies mechanical or hydraulic pressure to the brake disc

_____e. A cable which transfers braking action from a lever on the handlebar to the brake

_____f. The housing used to guide the brake cable so friction or sticking of the cable will be eliminated

_____g. A ratcheting-type gear found on disc brakes; used to maintain proper clearance between the pad and the disc

_____h. On hydraulic brake systems, the assembly which houses pads, hydraulic piston, and bleeder valve

_____i. Attached to the handlebars of a hydraulic brake system, and used as a reservoir to the brake fluid

_____j. On hydraulic brake systems, the mechanism which forces hydraulic fluid from the master cylinder through the hose to the calipers to supply pressure to the pucks

_____k. On hydraulic brake systems, it is used to actuate the plunger, forcing fluid to the calipers

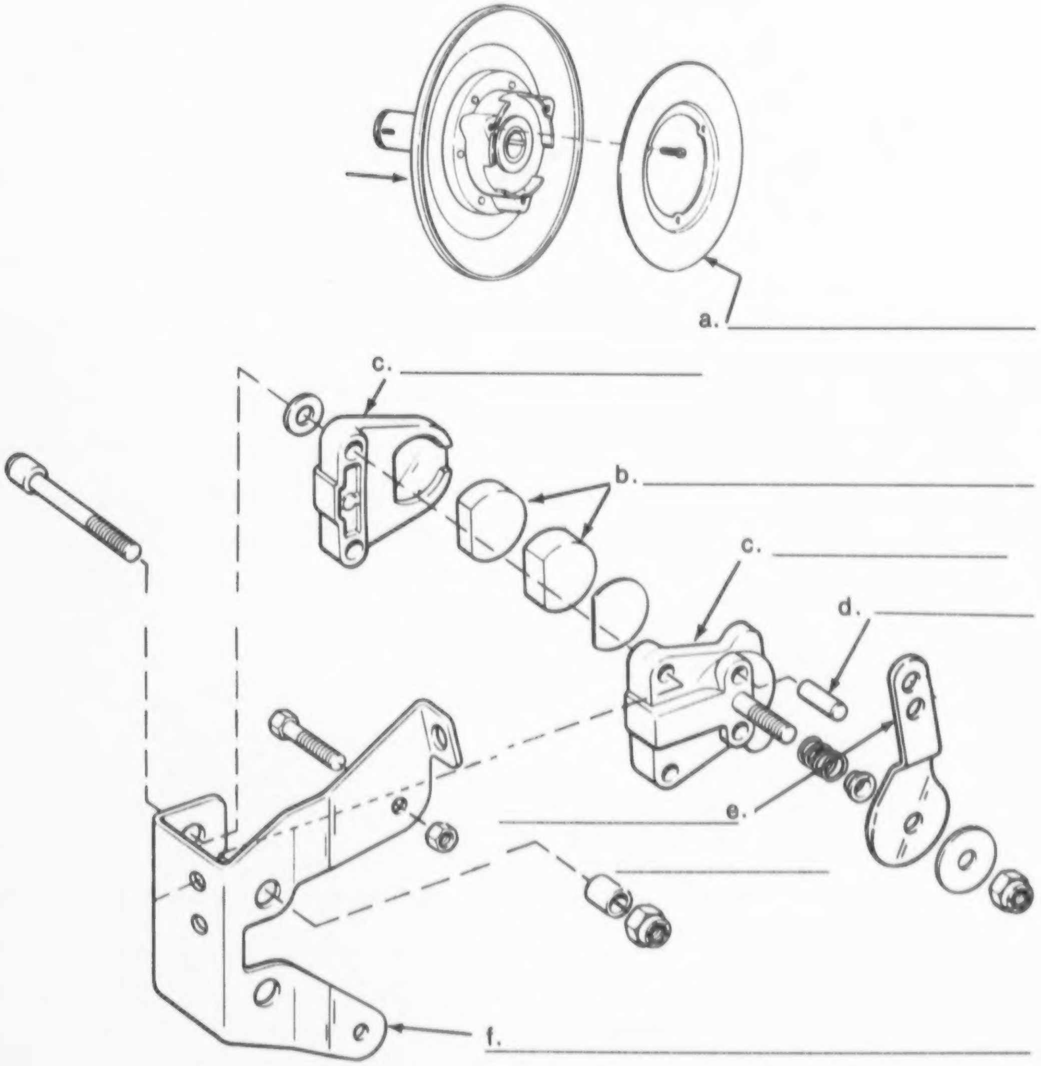
1. Plunger
2. Pad
3. Brake fluid
4. Hydraulic calipers
5. Disc brakes
6. Bleeder valve
7. Hydraulic brakes
8. Hand lever
9. Calipers
10. Master cylinder
11. Brake cable
12. Self-adjusting brake caliper
13. Cable housing

TEST

_____l. A small outlet in the caliper used to release air trapped in the system

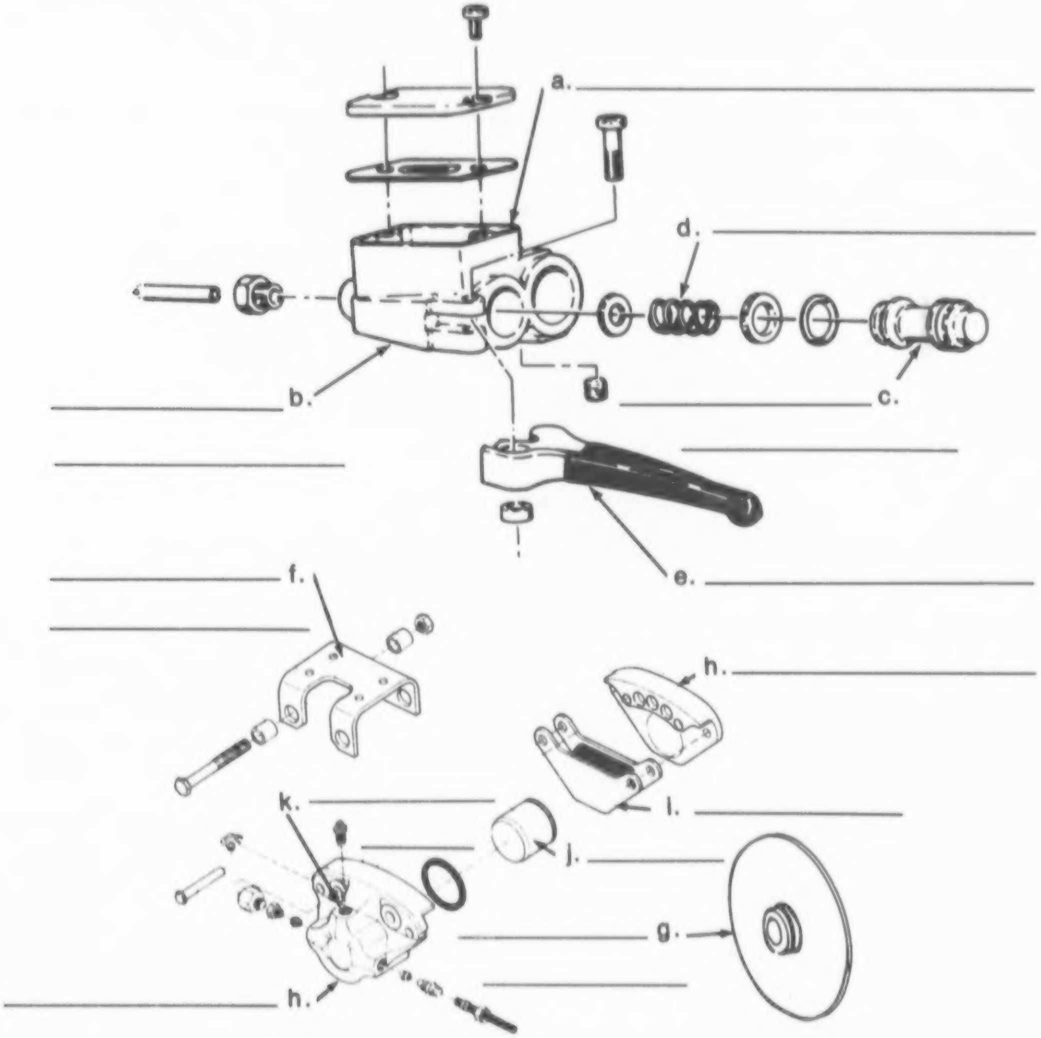
_____m. Hydraulic fluid used to transfer pressure from the master cylinder to the calipers

2. Identify parts of a typical disc brake unit by placing the correct component name in the appropriate blank.



TEST

3. Identify parts of a typical hydraulic brake unit by placing the correct component name in the appropriate blank.



4. Select true statements concerning types of brakes on snowmobiles by placing an "X" beside each statement that is true.

_____a. Manual disc brakes use discs attached directly or indirectly to the driven clutch to stop movement of the track, and are manually adjusted.

_____b. Self-adjusting cable-operated disc brakes are similar to the manual disc brakes except the system adjusts itself to the pressure required to activate the calipers.

TEST

_____c. Hydraulic brake systems also use discs but the discs are activated by pressure on the hand lever which compresses fluid activating a plunger and creating a pressure chamber in which a coil spring pressure holds the piston assembly against the face of the brake lever.

5. Complete statements concerning maintenance by inserting the word(s) that best completes each statement.

a. The most common maintenance which must be performed on both disc and hydraulic brake systems is ____________ ____________, primarily adjusting the brake cables so that the system activates to the correct pressure.

b. On most disc brake systems, the brake should be fully applied when the brake control lever on the handlebars is depressed about ____________ inch.

c. Self-adjusting disc brakes use a ratchet mechanism to maintain proper ____________ clearance.

d. A ____________ action on the hand brake lever on hydraulic brakes may indicate air in the system which requires the system to be bled of all trapped air.

e. During routine maintenance inspections, the brake system should be inspected for worn brake pads which must be replaced if less than ____________ remains.

f. During disassembly of the brake system it should be a routine operation to clean all metal components using a general purpose ____________ and a dry clean cloth.

g. When hydraulic fluid is not reaching the plunger mechanism to activate the brakes, it may be caused by a malfunctioning ____________ ____________ or an air lock, if the system has been recently drained.

h. Never allow oil, grease, or ____________ ____________ to contaminate the pads.

6. Select true statements concerning brake fluid by placing an "X" beside each statement that is true.

_____a. Before putting brake fluid into a system, always check the service manual for the type of fluid the system requires, and use only that fluid

_____b. Brake fluid will damage a painted surface almost instantly, and painted surfaces on a snowmobile should be protected with nonabsorbent coverings.

_____c. Old brake fluids should never be reused and should be disposed of ain an approved manner.

TEST

(NOTE: If the following activities have not been completed prior to the test, ask your instructor when they should be completed.)

7. Solve problems related to maintenance of brake systems. (Assignment Sheet #1)

8. Demonstrate the ability to:

   a. Disassemble and reassemble a disc brake. (Job Sheet #1)

   b. Adjust a disc brake. (Job Sheet #2)

   c. Bleed a hydraulic brake unit. (Job Sheet #3)

BRAKES
UNIT XI

ANSWERS TO TEST

1. a. 5
   b. 7
   c. 2
   d. 9
   e. 11
   f. 13
   g. 12
   h. 4
   i. 10
   j. 1
   k. 8
   l. 6
   m. 3

2. a. Brake disc plate
   b. Pads
   c. Caliper
   d. Plunger
   e. Actuator lever
   f. Brake support bracket

3. a. Fluid reservoir
   b. Master cylinder
   c. Master cylinder piston
   d. Return spring
   e. Hand lever
   f. Brake support bracket
   g. Brake disc plate
   h. Caliper
   i. Pads
   j. Piston
   k. Bleeder valve

4. a, b, [illegible]

5. a. Brake adjustment
   b. One-half
   c. Pad
   d. Spongy
   e. 1/8"
   f. Solvent
   g. Master cylinder
   h. Brake fluid

6. a, b, c

7. Evaluated to the satisfaction of the instructor

8. Performance skills evaluated according to procedures written in the job sheets

ENGINES
UNIT XII

UNIT OBJECTIVE

After completion of this unit, the student should be able to discuss basic principles of snowmobile engines and identify the types of engine cooling systems. The student should also be able to service a float-type carburetor and synchronize an oil pump with a carburetor. These competencies will be evidenced by correctly performing the procedures outlined in the assignment and job sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student will be able to:

1. Match terms related to engines with their correct definitions.
2. Complete statements concerning engine history.
3. Select true statements concerning two-stroke engine design.
4. Complete statements concerning snowmobile cooling systems.
5. Match components of a liquid-cooled system with their functions.
6. Complete a list of advantages of liquid-cooled systems.
7. Complete statements concerning lubrication systems.
8. Complete statements concerning types of carburetors.
9. Select true statements concerning fuel pumps.
10. Complete statements concerning cold start methods.
11. Select true statements concerning coolant/anti-freeze.
12. Complete statements concerning guidelines for engine service.
13. Solve problems related to engine maintenance. (Assignment Sheet #1)
14. Demonstrate the ability to:
    a. Service a float-type carburetor. (Job Sheet #1)
    b. Synchronize an oil pump with a carburetor. (Job Sheet #2)

ENGINES
UNIT XII

SUGGESTED ACTIVITIES

A. Provide students with objective sheet.

B. Provide students with information sheet.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Demonstrate and discuss procedures outlined in the job sheets.

G. Invite a local snowmobile dealer or salesman to talk to the class about the various engine sizes and designs which are available on today's snowmobiles.

H. Demonstrate how to synchronize carburetors.

I. Give test.

CONTENTS OF THIS UNIT

A. Objective sheet

B. Information sheet

C. Transparency masters

    1. TM 1 — Two-Stroke Engine Components and Power Cycle
    2. TM 2 — Liquid-Cooled Engine
    3. TM 3 — Slide-Throttle Carburetor

D. Assignment Sheet #1 — Solve Problems Related to Engine Maintenance

E. Answers to assignment sheet

F. Job sheets

    1. Job Sheet #1 — Service a Float-Type Carburetor
    2. Job Sheet #2 — Synchronize an Oil Pump With a Carburetor

G. Test

H. Answers to test

REFERENCES USED IN DEVELOPING THIS UNIT

A. *Comprehensive Small Engine Repair.* Stillwater, OK 74074: Mid-America Vocational Curriculum Consortium, 1977.

B. *Chilton's Snowmobiles Repair and Tune-Up Guide,* Second edition. Radnor, PA: Chilton Book Co., 1975.

C. *Arctic Cat Service Manual No. 2254-302.* Thief River Falls, MN 56701: ARCTCO, Inc. 1984.

D. *1980 Bombardier Snowmobiles Shop Manual.* Valcourt, Quebec, Canada: Bombardier, Ltd., 1980.

E. *1978 Polaris Shop Manual.* Roseau, MN: Polaris/Textron. 1978.

F. *Kawasaki Drifter Snowmobile Shop Manual.* Santa Ana, CA 92799-5252: Kawasaki Motors Corp., U.S.A., 1980.

G. *Kawasaki Parts Catalog SB340-A2, SB440-A5.* Santa Ana, CA 92799-5252: Kawasaki Motors Corp., U.S.A., 1980.

ENGINES
UNIT XII

INFORMATION SHEET

I. **Terms and definitions**

   A. Two-stroke engine — A small but powerful motor used on most modern snowmobiles

   B. Wankel rotary engine — A fan cooled, single rotary motor formerly used on some snowmobiles

   C. Piston — A component that rides in a cylinder and receives the force of combustion in an engine and transfers the energy to the connecting rod

   D. Connecting rod — The linkage between the piston and the crankshaft; the straightline movement of the piston is converted to rotating power at the crankshaft through the connecting rod

   E. Crankshaft — The backbone of the engine, it receives power from the connecting rod

   F. Carburetion — The system which provides an internal combustion engine with a controlled mixture of atomized fuel and air

   G. Cooling — Either by air, water or a combination of the two, it is a system for cooling the engine block

   H. Ignition timing — The point in the movement of the piston in which the spark plug fires in relation to the vertical travel of the piston

   I. Cylinder — The straight bore which encloses the piston

   J. Port — An opening in the cylinder which allows air and fuel into the engine or combustion chamber or allows exhaust gases to escape

II. **Engine history**

   A. The first vehicles which ran on snow were powered by four-cylinder engines, usually the engines used on cars like the Ford Model-T.

   B. In 1939, J.A. Bombardier designed a snow vehicle which was powered by a powerful 85 horsepower V8 engine.

   C. As the size of snowmobiles became smaller and more suited to personal travel, engine size dropped too, and by the mid-1950's snowmobile designs included 7 horsepower air-cooled outboard motors.

   D. During the 1950's, as designs for personal snowmobiles were being developed, two-stroke motorcycle engines became popular as the source of power for the vehicles.

INFORMATION SHEET

E. In the early 1970's the rotary engine was developed and several snowmobile models were designed with the rotary engine as a source of power.

F. Modern snowmobiles employ two-stroke engines which may be air or water cooled

III. Two-stroke engine design

A. Two-stroke engines are so named because the power cycle is accomplished in two strokes of the engine.

B. Modern snowmobile two-stroke engines have common components: (Transparency 1)

1. Piston
2. Connecting rod
3. Crankshaft
4. Crankcase
5. Cylinder
6. Cylinder head
7. Flywheel

C. Two-stroke engines must: (Transparency 1)

1. Intake the fuel/air mixture into the crankcase
2. Transfer the fuel/air mixture into the combustion chamber
3. Compress the mixture for combustion and ignition
4. Exhaust burned gases out of the combustion chamber

   (NOTE: In engine terminology, activities take place in relation of the piston's relationship to TDC, Top Dead Center, and BDC, Bottom Dead Center, and whether the activity takes place before or after either of the TDC or BDC positions.)

D. Modern two-stroke snowmobile engines use one of three different types of valving:

1. Piston port valves
2. Reed valves
3. Rotary

INFORMATION SHEET

IV. **Snowmobile cooling systems**

A. Cooling the engine on a snowmobile is necessary to prevent engine components from being destroyed by heat and to help maintain the most efficient temperature for correct engine performance.

B. Many snowmobile engines use air cooling from an engine driven fan or free air flow from outside the chassis.

C. Many high performance snowmobiles use a liquid cooling system to maintain safe engine temperatures.

V. **Components of a liquid-cooled system and their functions** (Transparency 2)

A. Radiator — Serves as the basic reservoir for the water/antifreeze mixture

B. Overflow tank — Catches boilover liquid

C. Reservoir tank — Backs up the radiator

D. Thermostat — Maintains coolant temperature

E. Cooling jacket — Distributes coolant around the cylinder and cylinder head

F. Cooling pump — Circulates coolant throughout the system

G. Heat exchanger — Located in the chassis tunnel so that the track will throw snow on it and help dissipate heat and enhance system cooling

VI. **Advantages of liquid-cooled systems**

A. The liquid reduces noise.

B. Liquid cooling permits operation at full throttle for longer periods of time.

C. Liquid cooling maintains a more constant engine temperature which permits higher horsepower outputs and increased engine reliability.

VII. **Lubrication systems**

A. All two-stroke engines require that oil be mixed with the fuel.

B. The oil serves two primary purposes: to lubricate the moving parts in the engine, and to enhance the internal cooling.

C. Since virtually all two-stroke engine oils contain additives, the oil also serves to clean the internal engine parts, prevent corrosion, and enhance anti-wear.

INFORMATION SHEET

D. Some snowmobiles require that the fuel and oil be mixed manually and added directly into the fuel tank.

E. Many contemporary snowmobiles inject the oil into the fuel or intake port as the snowmobile is operating.

VIII. **Types of carburetors** (Transparency 3)

A. Snowmobile carburetors are identified as either a float type or diaphragm type and by throttle valve design.

B. Throttle valve design may be:

1. Butterfly throttle valve
2. Slide valve throttle

C. Float bowl carburetors have either a slide throttle valve or a butterfly throttle valve.

D. Diaphragm type carburetors usually have a butterfly throttle valve.

IX. **Fuel pumps**

A. Fuel pumps deliver fuel from the fuel tank to the carburetor.

B. Fuel pumps may be integrated with the carburetor or mounted separately.

C. Most modern fuel pumps are a diaphragm type operated by crankcase pressure.

X. **Cold start methods**

A. A cold snowmobile engine will not vaporize droplets of fuel, and a richer mixture is required to start the engine.

B. Cold starting systems are called starter circuits or enrichment systems, and may be one of three types:

1. A manual pump or primer
2. An enrichment valve which opens a passageway direct from the float bowl to the carburetor throat
3. A choke plate

XI. **Coolant/Antifreeze**

A. Liquid-cooled snowmobiles require the use of a mixture of water and ethylene-glycol antifreeze which protects the mixture from boiling up to 264°F and from freezing down to -34°F.

INFORMATION SHEET

B. The antifreeze is mixed with water in a pre-mix solution before adding to the radiator, usually two quarts of antifreeze to two quarts water.

C. Manufacturers warn never to mix a concentration with more than 60 percent antifreeze and manufacturer's mixing directions should be carefully followed.

XII. **Guidelines for engine service**

A. Fuel filters may be located in the gas tank or in-line between the tank and the carburetor, and both filters and any screens should be checked and cleaned or replaced each season.

B. Some models equipped with in-line oil filters require purging air from the oil supply tube to avoid engine damage.

C. After carburetor replacement/adjustment, always synchronize the oil pump and carburetor to assure proper engine performance and proper lubrication.

D. In emergencies, a B.I.A. (Boating Industry of America) oil with a TC-W rating on the container may be used, but otherwise, use only oil recommended by the manufacturer.

E. Cure-all tune-up tonics and super oils are not recommended.

F. Synthetic oils are not recommended for most engines, but some manufacturers do recommend their use, so always check specifications.

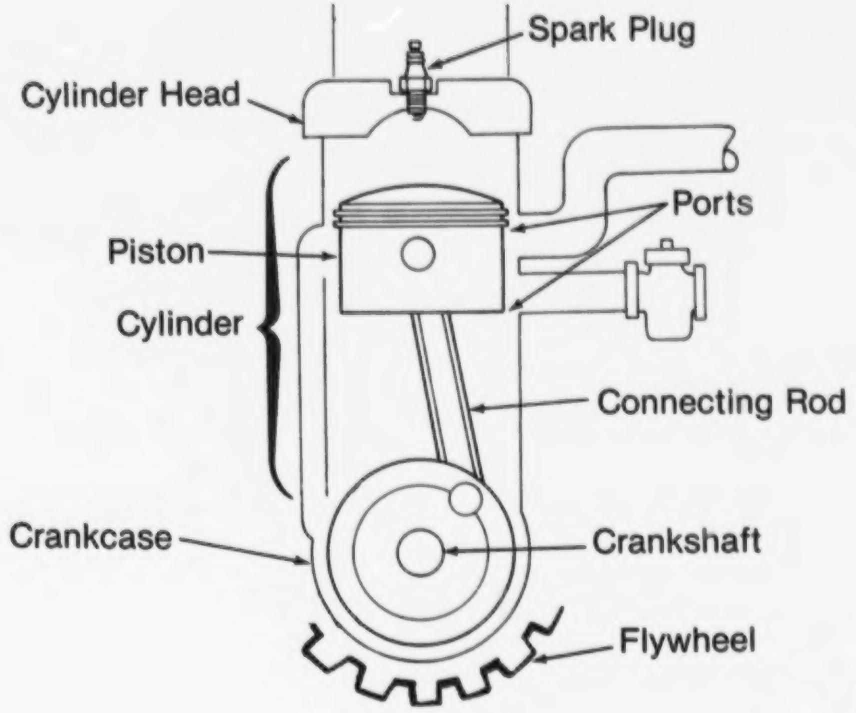
G. Add gasoline antifreeze each time the fuel tank is filled so that moisture trapped in fuel system components will not freeze and cause engine malfunction or damage.

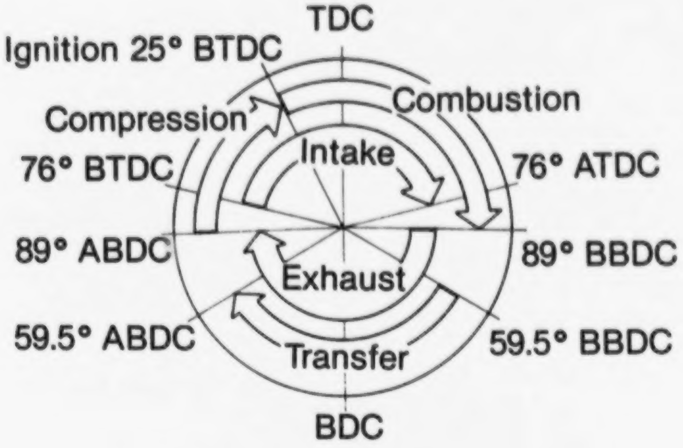
H. Liquid-cooled snowmachine engines should have the cooling system and reservoir tank cap pressure tested. Do not exceed recommended pressure, usually equal to pressure rating stamped on the tank cap.

I. Inspect exhaust system for proper mounting, sealing, cracks or damage to exhaust system components.

(NOTE: Do not leave ethylene-glycol in open containers where pets or small children may drink the solution. A few sips can be deadly.)

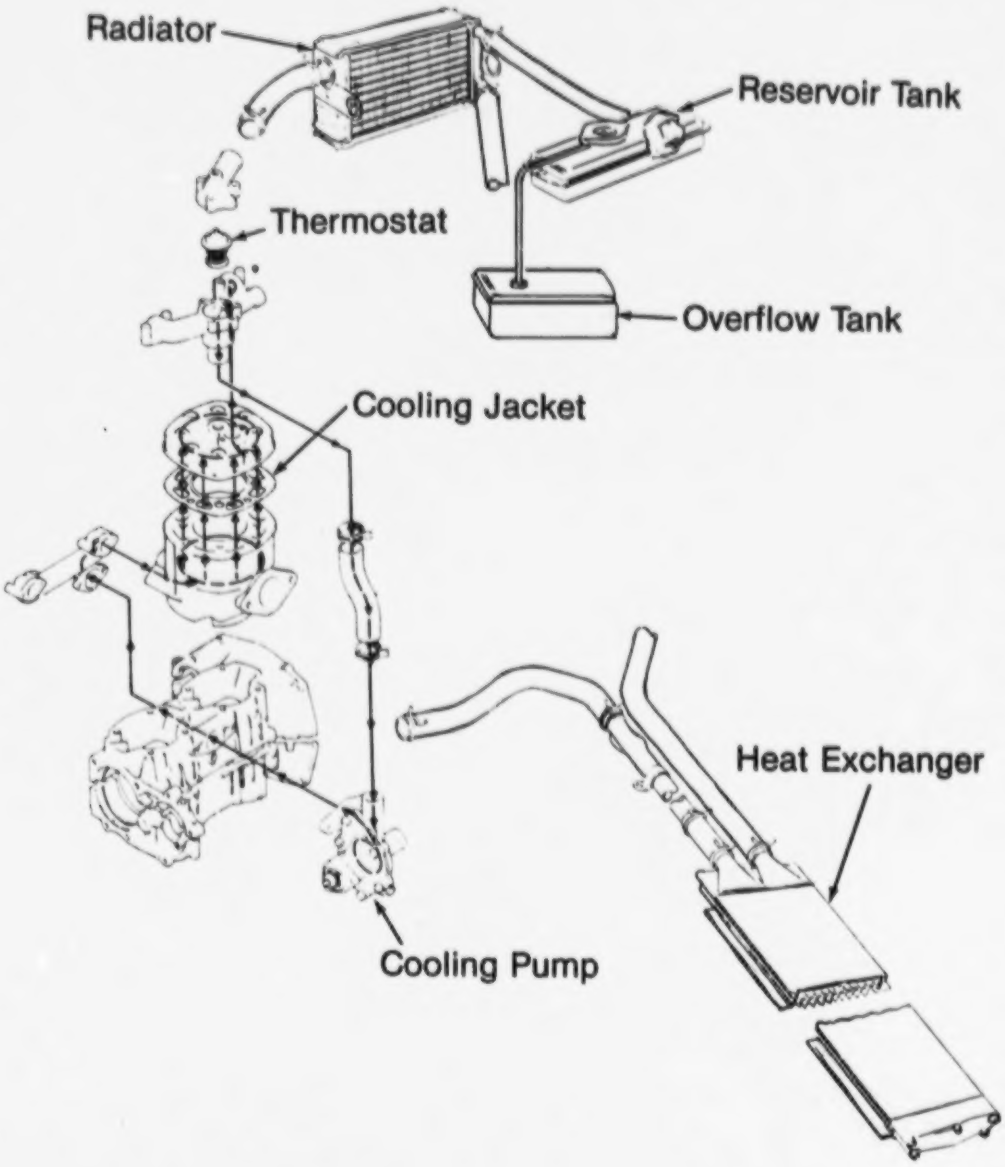
Two-Stroke Engine Components and Power Cycle


Spark Plug
Cylinder Head
Ports
Piston
Cylinder
Connecting Rod
Crankcase
Crankshaft
Flywheel


TDC
Ignition 25° BTDC
Combustion
Compression
Intake
76° BTDC
76° ATDC
89° ABDC
89° BBDC
Exhaust
59.5° ABDC
59.5° BBDC
Transfer
BDC

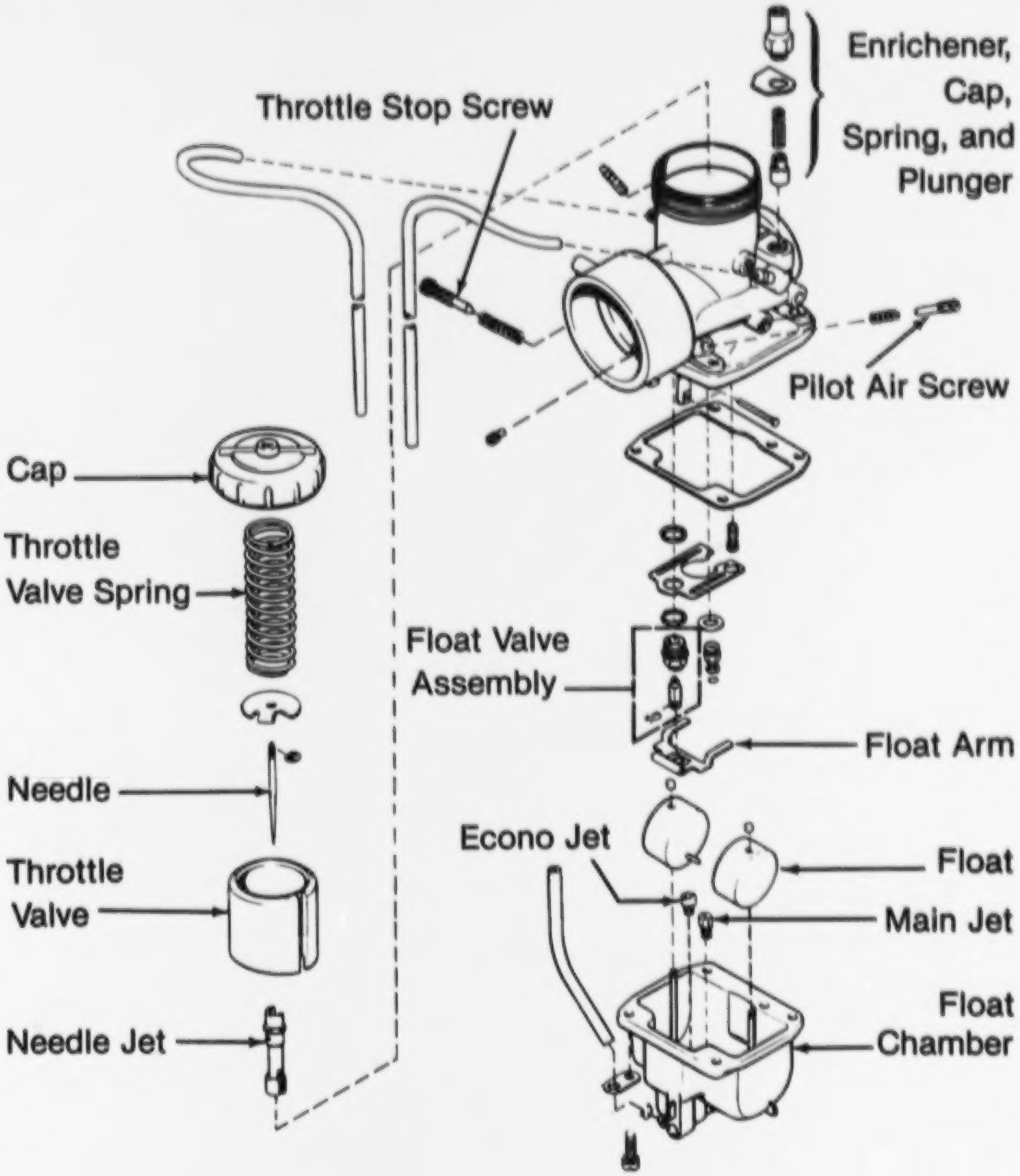
Courtesy Kawasaki Motors Corp., U.S.A.

Liquid-Cooled Engine


Radiator
Reservoir Tank
Thermostat
Overflow Tank
Cooling Jacket
Heat Exchanger
Cooling Pump

Courtesy Kawasaki Motors Corp., U.S.A.

Slide-Throttle Carburetor


Enrichener,
Cap,
Spring, and
Plunger
Throttle Stop Screw
Pilot Air Screw
Cap
Throttle
Valve Spring
Float Valve
Assembly
Float Arm
Needle
Econo Jet
Float
Main Jet
Throttle
Valve
Float
Chamber
Needle Jet

Courtesy Kawasaki Motors Corp., U.S.A.

ENGINES
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ASSIGNMENT SHEET #1 — SOLVE PROBLEMS RELATED TO ENGINE MAINTENANCE

A. There are three systems for starting a cold snowmobile engine. What is the purpose of each system?

____

____

B. What purposes does the introduction of oil into the crankcase serve?

____

____

C. What precaution must be taken in adding anti-freeze to a snowmobile's liquid-cooled engine system?

____

____

D. What distinguishes the three types of carburetors found on modern snowmobiles?

____

____

ENGINES
UNIT XII

ANSWERS TO ASSIGNMENT SHEET

A. All three systems inject extra raw gas to enrich the fuel to air ratio.

B. Oil serves the primary purpose of reducing friction of the engine parts by lubricating them, and by controlling temperature. Additionally, oil contains additives which clean engine parts, prevent rust, and enhance anti-wear.

C. The anti-freeze must be pre-mixed with water before introducing it into the coolant system, and that water/coolant mixture should not contain more than 60 percent anti-freeze.

D. The three types of carburetors are identifiable as a float type with a butterfly throttle valve, a float type with a slide valve throttle, and a diaphragm type carburetor.

ENGINES
UNIT XII

JOB SHEET #1 — SERVICE A FLOAT-TYPE CARBURETOR

A. Tools and materials

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Basic hand tools
4. Clean shop towels
5. Carburetor cleaner
6. Float level gauge
7. Compressed air supply
8. Drain pan
9. Safety glasses

B. Routine #1 — Removing the carburetor

1. Put on safety glasses.
2. Secure the sled with ignition off.
3. Disconnect and ground spark plug wire.
4. Turn the gas valve off and disconnect the fuel line.
5. Loosen the clamp on the air filter boot and remove the air filter boot from the carburetor.
6. Remove the throttle cable from the carburetor.

JOB SHEET #1

7. Unscrew the top of the carburetor. (Figure 1)

FIGURE 1

8. Pull the throttle slide and jet needle out of the top of the carburetor.

   (NOTE: From this point on refer to Figure 2 that accompanies this job sheet for general parts identification and component locations.)

9. Pull the throttle slide return spring up toward the carburetor top and reach in with a small screwdriver and remove the retaining clip from the throttle slide.

10. Disengage the throttle cable end and remove the throttle slide from the cable.

11. Remove the carburetor top and spring from the cable and set all the parts aside for cleaning and inspection.

12. Loosen the clamp or remove the nuts or bolts from the carburetor flange.

13. Remove the choke cable if there is one.

14. Remove the carburetor body and drain any fuel left in it into a drain pan.

15. Set the carburetor body aside for disassembly, cleaning, and inspection.

☐ Have your instructor check your work.

16. Clean up any gas that spilled as you removed the carburetor.

JOB SHEET #1

C. Routine #2 — Disassembling the carburetor

1. Leave your safety glasses on.
2. Remove the float chamber attaching screws and remove the float chamber from the carburetor.

   (NOTE: Make a sketch of where the float chamber hose guides come from so you can put them back in the right places.)
3. Use a pair of needlenose pliers to remove the float pin, and be sure it comes out from the correct side and in the right direction.

   (NOTE: If the pin is stuck, a punch can be used to free it, but proper support of the mounting boss is absolutely required, so if you can't get the pin out freely, ask your instructor for assistance.)
4. Remove the float and float valve and set them aside.
5. Remove the main jet, main jet holder, needle jet, baffle, and slow jet and set them aside.
6. Remove the limiter cap or the air screw plug.
7. Remove the throttle stop screw and set it aside with the air screw.
8. Unscrew the lock nut and remove the starter valve or enrichener.
9. Remove all O-rings that are on the air screw and enrichener valve, and remove the gasket from the mounting flange.
10. Place all metal parts and screws into a carburetor cleaner basket.

☐ Have your instructor check your work.

D. Routine #3 — Cleaning and inspecting carburetor parts

1. Leave your safety glasses on.
2. Place the basket of parts slowly into the carburetor cleaner to keep cleaner from splashing out.
3. Leave parts in the cleaner for fifteen to thirty minutes as specified on the cleaner directions.
4. Remove the carburetor basket from the cleaner, hook it over the side of the cleaning station, and permit it to drain.

JOB SHEET #1

5. Move the parts around with a screwdriver to make sure all the carburetor cleaner drains back into the tank.

6. Place the carburetor cleaning basket in a large drain pan and take it to the sink.

7. Rinse all parts thoroughly in cold water.

8. Take the parts back to the disassembly area and blow out all passages and thoroughly dry all parts with compressed air.

   (CAUTION: Small springs and screws are easy to lose when drying them with compressed air, so hang on tight.)

9. Lay the parts out on a clean shop towel as you dry them so they'll be ready for inspection.

10. Hold all jets up to the light and look through them to make sure the jet passage is unobstructed.

11. Clean obstructed jet passages with compressed air or an aerosol contact cleaner, but do not clean the jet with a wire or drill bit.

12. Replace any obstructed jets that cannot be cleaned with new ones.

13. Inspect the float needle for damage or wear which will appear as a circle that is worn around the seating surface of the needle.

14. Replace the needle and needle seat if the needle is worn.

15. Inspect the float pin for wear which will appear on the pin where the float works up and down the pin, and usually in the middle of the pin.

16. Replace the float pin if the old one is worn.

17. Inspect the float to make sure it hasn't collapsed, that it is securely soldered to the flat arms, and that there is no evident damage.

18. Shake the float close to your ear and listen for the presence of any fuel in the float.

19. Replace the float if the old one is bad.

20. Inspect the throttle slide for wear that usually appears as deep scratches or gouges.

21. Install the throttle slide into the carburetor body and make sure it slides freely.

22. Look down the throttle slide bore in the body of the carburetor, check for wear, and make sure the throttle slide guide pin is not worn or damaged.

JOB SHEET #1

23. Replace the throttle slide as required, but if the guide pin is damaged or missing the entire carburetor will have to be replaced.

    (NOTE: A new guide pin can be made from a proper size pin, but it's a job for an experienced technician.)

24. Inspect the jet needle for straightness and for wear which will appear along the body and at the point where the jet needle clip fits over it.

25. Inspect the jet needle clip to make sure it fits snugly in the appropriate groove on the jet needle.

26. Replace jet needle or clip as required.

27. Check the float bowl for damage caused by corrosion, and if the low speed jet is a part of the float bowl, squirt some contact cleaner on it to make sure it is open.

28. Clean the low speed jet with compressed air or otherwise replace the float bowl as required.

☐ Have your instructor check your work.

E. Routine #4 — Reassembling the carburetor

1. Leave your safety glasses on.

2. Install the float needle seat.

3. Install the starter valve or enrichener.

4. Install the main jet holder, needle jet, baffle, main jet, and slow jet in proper sequence and in their proper places.

   (NOTE: Do not overtighten these parts because they twist off easily, but be sure they are well seated.)

5. Install the air screw, turn it in until it is lightly seated, and then turn it out the same number of turns noted at disassembly

6. Install the throttle stop screw, turn it in until it is lightly seated, and then turn it out the same number of turns noted at disassembly — but screw it out one extra full turn.

   (NOTE: The extra full turn will help prevent the possibility of over revving the engine at start up.)

7. Install the float needle and the float, and you will probably have to install them as an assembly because there is a small wire clip that fastens them together.

JOB SHEET #1

8. Install the float pin.

9. Check the float level with a float level gauge and adjust to the specifications in the service manual.

   (NOTE: Float level adjustment varies from model to model and it's important to follow the specific procedure.)

10. Install the gasket or O-ring on the float bowl and install the float bowl.

11. Install the float chamber hose guides and float chamber screws, and snug the screws down lightly before tightening, but don't damage the fuel bowl by overtightening the screws.

12. Install the jet needle clip in its original groove.

13. Install the jet needle into the carburetor slide valve.

14. Install the throttle cable into the carburetor top.

15. Install the spring into the carburetor top and compress it with your hand so you can engage the throttle cable end into the throttle valve.

16. Install the retaining clip and let the spring go to allow it to seat into the throttle slide.

    (CAUTION: Make certain that the slide is installed in the correct position so that the groove along the throttle slide engages the guide pin in the throttle slide bore.)

17. Check to make sure that the cutaway at the bottom of the throttle slide faces the inlet side of the carburetor.

18. Push the throttle slide down into the bore.

19. Put the carburetor top back on, make sure it is straight, and screw it on carefully because it's very easy to cross thread and ruin the carburetor.

20. Look into the bore of the carburetor as you turn the throttle to make certain that the throttle slide operates smoothly and does not stick or bind.

☐ Have your instructor check your work.

F. Routine #5 — Installing and adjusting the carburetor

1. Leave your safety glasses on.

2. Look inside the carburetor flange and inside the air boot to make sure they are both free of dirt, pieces of old gasket, or foreign matter of any kind.

JOB SHEET #1

3. Replace the carburetor on the sled, taking care not to damage any rubber flanges, O-rings, or gaskets.

4. Check to make sure gaskets or rubber flanges are fitting properly onto the carburetor as you snug down the clamps or bolts.

   (NOTE: Do not tighten up one side of the carburetor and then the other or it will damage the carburetor; rather, snug all the bolts down first and then use an alternating sequence to tighten, but not overtighten, the bolts.)

5. Work the throttle to make sure it isn't sticking or binding.

6. Check all mating surfaces to be sure they are seated properly on rubber flanges or gaskets.

7. Check the back side of the air boot to make sure it has not been displaced from the air box.

☐ Have your instructor check your work.

8. Install the fuel line.

9. Turn the fuel on.

10. Put the spark plug wire back.

11. Check with your instructor to see if you are to start the engine so you can make final adjustments on the carburetor.

12. Start the engine and let it warm up to operating temperature.

13. Adjust the idle speed to specifications.

14. Continue final adjustment as outlined in the service manual.

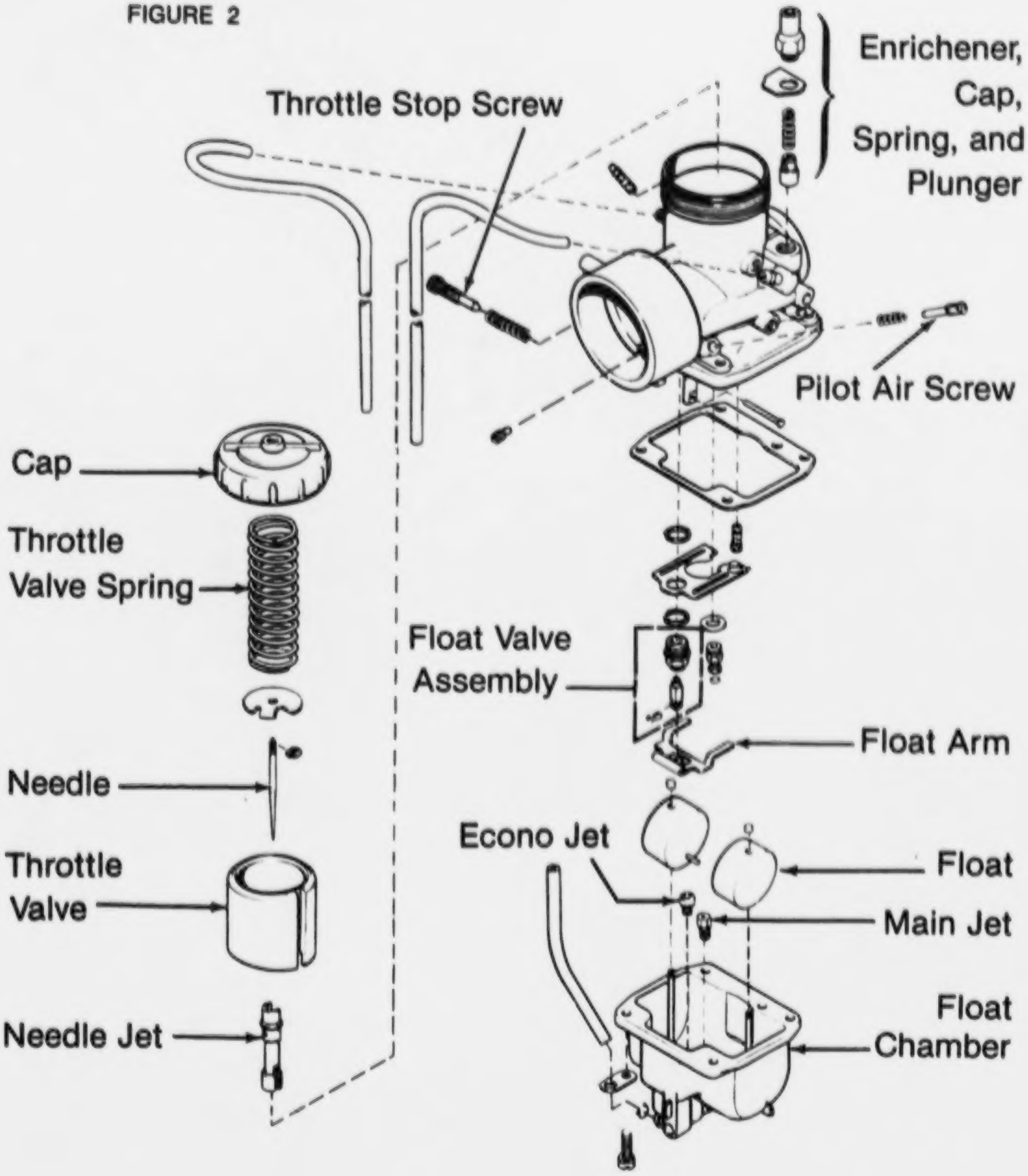
☐ Have your instructor check your work.

15. Stop the engine.

16. Clean up area and return tools and materials to proper storage.

JOB SHEET #1

FIGURE 2


Throttle Stop Screw
Enrichener, Cap, Spring, and Plunger
Pilot Air Screw
Cap
Throttle Valve Spring
Float Valve Assembly
Float Arm
Needle
Econo Jet
Float
Main Jet
Throttle Valve
Float Chamber
Needle Jet

Courtesy Kawasaki Motors Corp., U.S.A.

ENGINES
UNIT XII

JOB SHEET #2 — SYNCHRONIZE AN OIL PUMP WITH A CARBURETOR

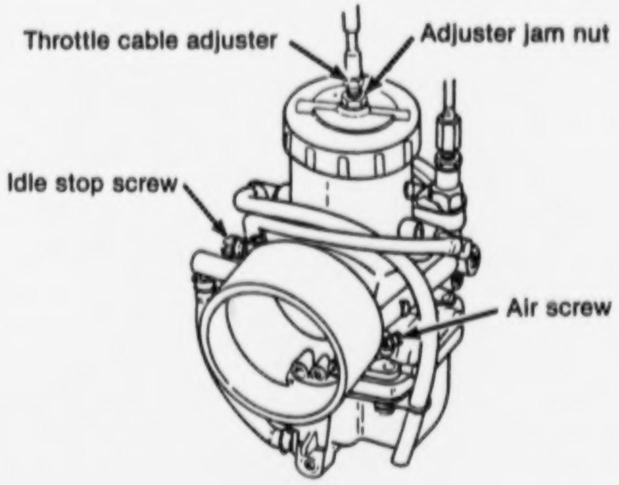
A. Tools and materials

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Basic hand tools
4. Rubber band
5. Safety glasses

B. Routine #1 — Synchronizing the oil pump

1. Put on safety glasses.
2. Remove the drive belt and silencer assembly.
3. Loosen the idle stop screw so that the throttle slide bottoms out in the bore of the carburetor. (Figure 1)
4. Make sure the throttle slide has bottomed out, and loosen the jam nut and turn the throttle cable adjuster to allow the slide to bottom out, just to make sure. (Figure 1)

FIGURE 1

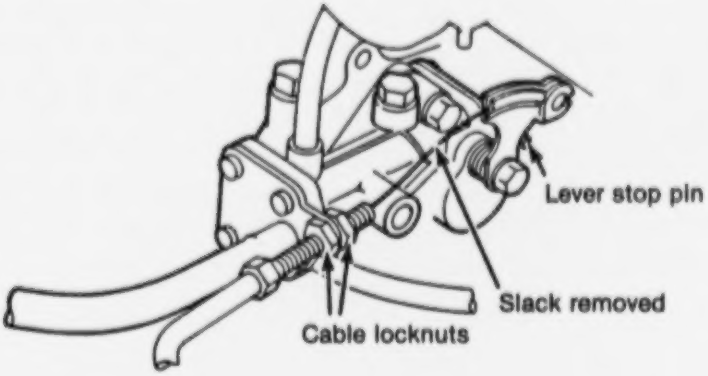


Courtesy Kawasaki Motors Corp., U.S.A.

JOB SHEET #2

5. Push the oil pump lever forward until it contacts the stop pin in order to insure that the oil pump is at dead idle position. (Figure 2)

FIGURE 2



Courtesy Kawasaki Motors Corp., U.S.A.

6. Adjust the throttle cable on the carburetor so that all slack is removed.

7. Check to make sure that the throttle slide begins to rise when the throttle lever on the handlebar is depressed.

8. Loosen the locknuts on the oil pump cable, and hold the oil pump lever against the stop pin as you remove all slack. (Figure 2)

9. Check to make sure that the lever on the oil pump and the throttle slide move simultaneously when the throttle control lever is depressed.

10. Turn the idle screw in until the spring is coil bound, then back the idle screw off six complete turns for initial adjustment.

11. Check air screw adjustment by seating the air screw, then turning it out a turn and a half.

☐ Have your instructor check your work.

12. Continue purging air from the oil pump tubes as outlined in the next routine.

C. Routine #2 — Purging air from the oil pump outlet tubes

1. Leave your safety glasses on.

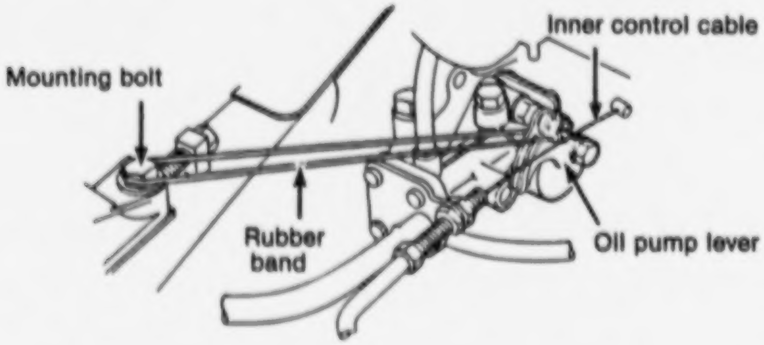
JOB SHEET #2

2. Disconnect the oil pump inner control cable from the oil pump control lever. (Figure 3)

   (NOTE: Do not disturb the cable locknuts as you remove the inner cable because the locknuts must stay in place.)

3. Attach a rubber band so that it holds the oil pump control lever wide open to permit the maximum flow of oil through the outlet tubes. (Figure 3)

FIGURE 3



Courtesy Kawasaki Motors Corp., U.S.A.

4. Secure the sled so that the engine can be started and operated safely.

5. Start the engine and adjust the idle stop screw to obtain an engine idle speed of 2,500 RPM.

   (NOTE: Adjustment procedures vary from model to model, so check your service manual.)

6. Permit the engine to run for one minute to provide ample time to purge all air from the oil pump outlet tubes.

7. Stop the engine after one minute of operation.

8. Remove the rubber band and reconnect the inner control cables to the oil pump lever.

9. Check operation of the oil pump control lever and cable by activating the throttle control lever on the handlebar.

☐ Have your instructor check your work.

10. Clean up area and return tools and materials to proper storage.

ENGINES
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NAME ______________________

TEST

1. Match terms related to engines with their correct definitions.

______a. A small but powerful motor used on most modern snowmobiles

______b. A fan cooled, single rotary motor formerly used on some snowmobiles

______c. A component that rides in a cylinder and receives the force of combustion in an engine and transfers the energy to the connecting rod

______d. The linkage between the piston and the crankshaft; the straightline movement of the piston is converted to rotating power at the crankshaft through the connecting rod

______e. The backbone of the engine, it receives power from the connecting rod

______f. The system which provides an internal combustion engine with a controlled mixture of atomized fuel and air

______g. Either by air, water or a combination of the two, it is a system for cooling the engine block

______h. The point in the movement of the piston in which the spark plug fires in relation to the vertical travel of the piston

______i. The straight bore which encloses the piston

______j. An opening in the cylinder which allows air and fuel into the engine or combustion chamber or allows gases to escape

1. Cooling
2. Port
3. Carburetion
4. Cylinder
5. Ignition timing
6. Connecting rod
7. Two-stroke engine
8. Crankshaft
9. Piston
10. Wankel rotary engine

2. Complete statements concerning engine history by circling the word(s) or figure(s) that best completes each statement.

   a. The first vehicles which ran on snow were powered by **(four-cylinder, eight-cylinder)** engines, usually the engines used on cars like the Ford Model-T.

   b. In 1939, **(Carl Eliason, J.A. Bombardier)** designed a snow vehicle which was powered by a powerful 85 horsepower V8 engine.

TEST

c. As the size of snowmobiles became smaller and more suited to personal travel, engine size dropped too, and by the mid-1950's snowmobile designs included 7 horsepower (**water-cooled, air-cooled**) outboard motors.

d. During the 1950's, as designs for personal snowmobiles were being developed, two-stroke (**motorcycle, outboard**) engines became popular as the source of power for the vehicles.

e. In the early (**1960's, 1970's**) the rotary engine was developed and several snowmobile models were designed with the rotary engine as the source of power.

f. Modern snowmobiles employ (**four-stroke, two-stroke**) engines which may be air or water cooled.

3. Complete statements concerning two-stroke engine design by inserting the word(s) that best completes each statement.

a. Two-stroke engines are so named because the ____________ cycle is accomplished in two strokes of the engine.

b. Modern snowmobile two-stroke engines have common components:

1) ____________

2) ____________ ____________

3) ____________

4) Crankcase

5) ____________

6) Cylinder head

7) Flywheel

c. Two-stroke engines must:

1) ____________ the fuel/air mixture into the crankcase

2) ____________ the fuel/air mixture into the combustion chamber

3) ____________ the mixture for combustion and ignition

4) ____________ burned gases out of the combustion chamber

d. Modern two-stroke snowmobile engines use one of three different types of valving:

1) Piston port valves

2) Reed valves

3) Rotary

TEST

4. Complete statements concerning snowmobile cooling systems by inserting the word(s) that best completes each statement.

   a. Cooling the engine on a snowmobile is necessary to prevent engine components from being destroyed by heat and to help obtain the most efficient ____________ for correct engine performance.

   b. Many snowmobile engines use air cooling from an engine driven fan or ____________ air flow from outside the chassis.

   c. Many high performance snowmobiles use a ____________ cooling system to maintain safe engine temperatures.

5. Match components of a liquid-cooled system with their functions.

   _____a. Serves as the basic reservoir for the water/anti-freeze mixture

   _____b. Catches boilover liquid

   _____c. Backs up the radiator

   _____d. Maintains coolant temperature

   _____e. Distributes coolant around the cylinder and cylinder head

   _____f. Circulates coolant throughout the system

   _____g. Located in the chassis tunnel so that the track will throw snow on it and help dissipate heat and enhance system cooling

   1. Reservoir tank
   2. Heat exchanger
   3. Cooling jacket
   4. Radiator
   5. Cooling pump
   6. Thermostat
   7. Overflow tank

6. Complete a list of advantages of liquid-cooled systems by inserting the word(s) that best completes each statement,

   a. The liquid reduces ____________.

   b. Liquid cooling permits operation at full ____________ for longer periods of time.

   c. Liqud cooling maintains a more ____________ engine temperature which permits higher horsepower outputs and increased engine reliability.

7. Complete statements concerning lubrication systems by circling the word(s) that best completes each statement.

   a. All (**two-stroke, four-stroke**) engines require that oil be mixed with the fuel.

   b. The oil serves two primary purposes: to lubricate the (**moving parts, piston rings**) in the engine, and to enhance the internal cooling.

TEST

c. Since virtually all two-stroke engine oils contain additives, the oil also serves to clean the **(internal, external)** engine parts, prevent corrosion, and enhance anti-wear.

d. Some snowmobiles require that the fuel and oil be mixed manually and added directly into the **(crankcase, fuel tank)**.

e. Many contemporary snowmobiles inject the oil into the fuel or **(intake, exhaust)** port as the snowmobile is operating.

8. Complete statements concerning types of carburetors by inserting the word(s) that best completes each statement.

   a. Snowmobile carburetors are identified as either a________________ type or ________________ type and by throttle valve design.

   b. Throttle valve design may be:

      1. ________ ____________ valve

      2. ______________ throttle

   c. Float bowl carburetors have either a slide throttle valve or a ____________ throttle valve.

   d. Diaphragm type carburetors usually have a ____________ throttle valve.

9. Select true statements concerning fuel pumps by placing an "X" beside each statement that is true.

_____a. Fuel pumps deliver fuel from the fuel tank to the carburetor.

_____b. Fuel pumps are always integrated with the carburetor.

_____c. Most modern fuel pumps are a diaphragm type operated by crankcase pressure.

10. Complete statements concerning cold start methods by inserting the word(s) that best completes each statement.

   a. A cold snowmobile engine will not ____________ droplets of fuel, and a richer mixture is required to start the engine.

   b. Cold starting systems are called starter circuits or enrichment systems, and may be one of three types:

      1) A ____________ pump or primer

      2) An enrichment ____________ which opens a passageway direct from the float bowl to the carburetor throat

      3) A ____________ plate

TEST

11. Select true statements concerning coolant/antifreeze by placing an "X" beside each statement that is true.

    _____a. Liquid-cooled snowmobiles require the use of a mixture of water and ethylene-glycol antifreeze which protects the mixture from boiling up to 264°F and from freezing down to -34°F.

    _____b. The antifreeze is mixed with water in a pre-mix solution before adding to the radiator, usually two quarts of antifreeze to two quarts water.

    _____c. Manufacturers warn never to mix a concentration with more than 60 percent antifreeze and manufacturer's mixing directions should be carefully followed.

12. Complete statements concerning guidelines for engine service by inserting he word(s) that best completes each statement.

    a. Fuel filters may be located in the gas tank or _____________ _____________ between the tank and the carburetor, and both filters and any screens should be checked and cleaned or replaced each season.

    b. Some models equipped with in-line oil filters require _____________ air from the oil supply tube to avoid engine damage.

    c. After carburetor replacement/adjustment, always _____________ the oil pump and carburetor to assure proper engine performance and proper lubrication.

    d. In emergencies, a B.I.A. oil with a TC-W rating _____________ _____________ _____________ may be used, but otherwise, use only oil recommended by the manufacturer.

    e. Cure-all tune-up tonics and _____________ oils are not recommended.

    f. _____________ oils are not recommended for most engines, but some manufacturers do recommend their use, so always check specifications.

    g. Add gasoline _____________ each time the fuel tank is filled so that moisture trapped in fuel system components will not freeze and cause engine malfunction or damage.

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

13. Solve problems related to engine maintenance. (Assignment Sheet #1)

14. Demonstrate the ability to:

    a. Service a float-type carburetor. (Job Sheet #1)

    b. Synchronize an oil pump with a carburetor. (Job Sheet #2)

ENGINES
UNIT XII

ANSWERS TO TEST

1. a. 7 f. 3
   b. 10 g. 1
   c. 9 h. 5
   d. 6 i. 4
   e. 8 j. 2

2. a. Four-cylinder
   b. J.A. Bombardier
   c. Air-cooled
   d. Motorcycle
   e. 1970's
   f. Two-stroke

3. a. Power
   b. 1) Piston
      2) Connecting rod
      3) Crankshaft
      5) Cylinder
   c. 1) Intake
      2) Transfer
      3) Compress
      4) Exhaust

4. a. Temperature
   b. Free
   c. Liquid

5. a. 4
   b. 7
   c. 1
   d. 6
   e. 3
   f. 5
   g. 2

6. a. Noise
   b. Throttle
   c. Constant

7. a. Two-stroke
   b. Moving parts
   c. Internal
   d. Fuel tank
   e. Intake

ANSWERS TO TEST

8. a. Float, diaphragm
   b. 1) Butterfly throttle
      2) Slide valve
   c. Butterfly
   d. Butterfly

9. a, c

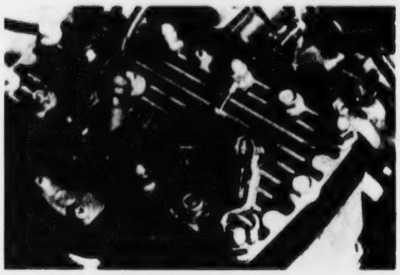
10. a. Vaporize
    b. 1) Manual
       2) Valve
       3) Choke

11. a, b, c

12. a. In-line
    b. Purging
    c. Synchronize
    d. On the container
    e. Super
    f. Synthetic
    g. Antifreeze

13. Evaluated to the satisfaction of the instructor

14. Performance skills evaluated according to procedures written in the job sheets.



IGNITION AND ELECTRICAL SYSTEMS
UNIT XIII

UNIT OBJECTIVE

After completion of this unit, the student should be able to discuss types of ignition systems and identify components of a capacitor discharge ignition systems. The student should also be able to discuss procedures for servicing components of ignition systems, service a battery and spark plugs, troubleshoot a CDI system, and service a recoil starter. These competencies will be evidenced by correctly performing the procedures outlined in the job sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student will be able to:

1. Match terms related to ignition and electrical systems with their correct definitions.
2. Select true statements concerning snowmobile electrical requirements.
3. Complete statements concerning battery ignition systems.
4. Solve problems concerning battery service.
5. Select true statements concerning magneto ignition systems.
6. Complete statements concerning capacitor discharge systems.
7. Identify components of a CDI system.
8. Complete statements concerning CDI operations.
9. Complete statements concerning safety features in a CDI system.
10. Solve problems concerning spark plug service.
11. Complete statements concerning how to use spark plug wear as troubleshooting guidelines.
12. Select true statements concerning recoil starter service.

OBJECTIVE SHEET

13. Complete statements concerning servicing the electrical system.

14. Demonstrate the ability to:

    a. Remove, inspect, service, and replace a snowmobile battery. (Job Sheet #1)

    b. Remove and inspect ignition coil leads. (Job Sheet #2)

    c. Remove, inspect, and replace spark plugs. (Job Sheet #3)

    d. Check ignition timing. (Job Sheet #4)

    e. Troubleshoot a capacitor discharge ignition system. (Job Sheet #5)

    f. Service a recoil starter. (Job Sheet #6)

IGNITION AND ELECTRICAL SYSTEMS
UNIT XIII

SUGGESTED ACTIVITIES

A. Provide students with objective sheet.

B. Provide students with information sheet.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Demonstrate and discuss procedures outlined in the job sheets.

G. Provide students with samples of common electrical problems and have students discuss how they would solve them.

H. Give test.

CONTENTS OF THIS UNIT

A. Objective sheet

B. Information sheet

C. Transparency masters

   1. TM 1 — Capacitor Discharge Ignition System
   2. TM 2 — Parts of a Spark Plug
   3. TM 3 — Parts of a Recoil Starter

D. Job sheets

   1. Job Sheet #1 — Remove, Inspect, Service, and Replace a Snowmobile Battery
   2. Job Sheet #2 — Remove, Inspect, and Replace Spark Plugs
   3. Job Sheet #3 — Check Ignition Timing
   4. Job Sheet #4 — Troubleshoot a Capacitor Discharge Ignition System
   5. Job Sheet #5 — Service a Recoil Starter

E. Test

F. Answers to test

REFERENCES USED IN DEVELOPING THIS UNIT

A. *Arctic Cat Service Manual #2254-302.* Thief River Falls, MN 56701: ARTCO, Inc., 1984.

B. *1980 Bombardier Snowmobiles Shop Manual.* Valcourt, Quebec, Canada: Bombardier, Ltd., 1980.

C. *Chilton's Snowmobiles Repair and Tune-Up Guide.* Radnor, PA: Chilton Book Co., 1975.

D. *Kawasaki Drifter Snowmobile Shop Manual.* Santa Ana, CA 92799-5252: Kawasaki Motors Corp., U.S.A., 1980.

E. *Kawasaki Parts Catalog SB340-A2, SB440-A5.* Santa Ana, CA 92799-5252: Kawasaki Motors Corp., U.S.A., 1980.

F. *Honda Motorcycle Electrical Systems.* Gardena, CA: American Honda Motor Co., Inc., 1977.

IGNITION AND ELECTRICAL SYSTEMS
UNIT XIII

INFORMATION SHEET

I. **Terms and definitions**

A. Alternating current — Electric current which reverses its direction of flow at regular intervals

B. Direct current — Electric current which flows in only one direction

C. Ampere — The unit of measurement for current flow

D. Volt — The unit of measurement of electrical pressure

E. Ohm — The unit of measurement of resistance to electrical flow

F. Alternator — A generator which produces alternating current

G. Capacitor — A device capable of storing limited amounts of electrical power for discharge at a predetermined time or on a predetermined signal

H. Rectifier — A device that changes alternating current into direct current

I. Induction — The process of charging an object by bringing it into the magnetic field of an electromagnet or permanent magnet

II. **Snowmobile electrical requirements**

A. The two basic electrical needs on a snowmobile are:

1. An ignition system to ignite the fuel/air mixture
2. An electrical system to operate lights and other accessories

B. Starting a snowmobile engine can be accomplished with a battery-based electric start unit or with a recoil starter that is manually operated.

C. Electrical demands for ignition and for lighting and accessories are two separate functions, and although the two systems are related, they operate as individual systems.

D. An ignition system produces high voltage required to jump the gap of the spark plug electrodes and ignite the air/fuel mixture in the combustion chamber of the engine.

E. Lower voltage alternating current is used for lights and accessories, and AC output is stabilized through a voltage regulator.

INFORMATION SHEET

III. **Battery ignition systems**

A. Battery ignition systems are found mostly on older sleds.

B. In a battery ignition system, the battery supplies electrical current to the starter or cranking motor which is a DC motor that works with brushes and a commutator.

C. The battery supplies power for the primary ignition circuit, and timing is accomplished with breaker points and a condenser.

D. When breaker points are replaced in this type system, the condenser should also be replaced.

E. A battery ignition system may produce up to 10,000 volts to fire the spark plugs, and AC electricity for lights and accessories are on a separate alternate circuit.

F. Alternator output is also used to charge the battery.

(NOTE: A rectifier is used to convert AC from the alternator into DC for battery charging, but the majority of alternator output is used for AC lights and accessories.)

G. Cranking motors or starters should not be operated continuously for more than 30 seconds, and a cool-down period of 30 seconds or more should be observed at starting intervals.

H. Demands of cold weather, vibration, and frequent stopping/starting require that batteries be inspected frequently for proper electrolyte level, corrosion-free connections, and proper venting.

IV. **Battery service**

A. The most important element of battery service is safety because batteries have a potential to explode, and battery electrolyte contains an acid that can quickly eat through clothes and burn skin.

B. The battery should always be inspected after long storage periods or after the sled has been subjected to high vibrations.

C. When servicing a battery, ALWAYS WEAR SAFETY GLASSES.

D. Always start battery service by first removing the negative battery cable, and replace the negative battery cable last.

E. Clean dirty battery cases with a soda solution.

F. Clean battery posts and cable connectors with soda and water, and then use a wire brush to make posts and connectors shine so they will make good contact.

INFORMATION SHEET

G. When battery electrolyte is low, it should be brought up to normal by adding distilled water, but never overfill a battery.

H. **After adding distilled water, charge the battery at a rate equal to 10% of the battery amp hour rating so the water will mix thoroughly and until the electrolyte specific gravity is 1.260+, to keep the electrolyte from freezing. A higher charging rate could damage the battery.**

I. A battery with a cracked or worn ease or one that evidences other abuse should be replaced.

J. After charging, a battery should be checked cell by cell with a hydrometer to determine if the specific gravity of each cell is okay.

(NOTE: The procedure for using a hydrometer to check for specific gravity is outlined in Job Sheet #1 of this unit.)

V. **Magneto ignition systems**

A. Magneto ignition systems use rotating magnets to induce current in the primary ignition circuit.

B. **Magneto ignition systems may be an energy transfer type. Timing is accomplished with breaker points and a condenser, and are serviced like other breaker point/condenser systems.**

C. A magneto ignition system may produce up to 10,000 volts to fire the spark plugs, and uses an alternator to provide AC electricity for lights and accessories.

VI. **Capacitor discharge ignition systems** (Transparency 1)

A. Capacitor discharge ignitions systems are the most common ignition systems found on modern snowmobiles.

B. CDI systems are popular because they do not use breaker points and are easy to service.

C. CDI systems use rotating magnets to induce current into a capacitor which stores the current until another impulse causes the capacitor to discharge and fire the spark plugs.

D. A CDI system may produce as high as 40,000 volts to fire the spark plugs, and this gives the CDI system an extra punch that also makes it more popular than other ignition systems.

E. A CDI system has a lighting coil to provide AC electricity to the voltage regulator for operating lights and accessories.

INFORMATION SHEET

VII. **Components and their functions in a CDI system** (Transparency 1)

A. Flywheel — Houses four permanent magnets which provide a moving magnetic field as the flywheel rotates around the coils in the stator assembly.

B. Stator assembly — Houses the exciter, pulsing, and lighting coils.

C. Exciter coil — Charges the capacitor in the CDI igniter.

D. Pulser coil — Signals the capacitor in the CDI igniter when to release its charge to the ignition coil.

E. Ignition coil — A coil with primary and secondary windings that induce the high voltage needed to jump the air gap on the spark plugs.

F. Lighting coil — Provides alternating current for the lights and instruments in the electrical system.

VIII. **CDI operations**

A. As the flywheel rotates, alternating current is induced in the coils mounted on the stator.

B. The exciter coil sends a charge to the capacitor which stores the charge, and the amount of charge the exciter coil gives the capacitor affects the intensity of the spark.

C. The pulser coil causes the capacitor in the CDI igniter to release its stored energy, but the pulser coil is only a signaling device and it has no effect on the intensity of the spark.

D. The primary winding in the ignition coil induces a high voltage in the secondary winding of the ignition coil, and causes a spark to jump across the spark plug electrodes.

E. The igniter coil fires high voltage charges to the spark plugs twice each time the flywheel makes one complete rotation.

IX. **Safety features in a CDI system**

A. For both safety and convenience, a snowmobile engine needs to stop and start at the turn of a switch, but the sled also needs to stop if the rider should lose control and fall off.

B. The key switch on a snowmobile permits the engine to be started or stopped with the turn of a key and services both safety and convenience.

C. The emergency stop switch is strictly a safety device that will stop the engine if the rider is thrown off and the throttle handle is suddenly released.

INFORMATION SHEET

D. Together, the key switch and emergency stop switch function to protect both the sled and the rider, and they are both connected to CDI igniter leads.

E. The two switches work independently of each other, and when either switch is positioned to STOP, all charging to the capacitor stops, there can be no charge transmitted from the igniter coil to the spark plugs, and the sled stops.

F. The key switch and emergency stop switch should never be altered, and a sled with problems in either of these circuits should not be used until the problems are corrected.

X. **Spark plug service** (Transparency 2)

A. Spark plugs should be inspected at periods specified by the manufacturer, and should always be replaced if they are worn.

B. Before removing a spark plug for inspection, always clean dirt, oil, or debris from around the spark plug engine area so that nothing will fall into the combustion chamber.

C. Discard and replace all spark plugs that have:

1. Excessive electrode wear
2. Cracks in the insulator
3. **Gray or brownish stains on the outer surface of the insulator near the shell indicate a cylinder gas leak and/or electrical corona discharge.**

D. Always select replacement spark plugs of the appropriate size and heat range as specified by the manufacturer.

XI. **How to use spark plugs wear as troubleshooting guidelines**

A. Discoloration and fouling are two ways that the condition of a spark plug can reflect other operating conditions that need attention.

B. After service, a spark plug used with regular gas will be a shade of brown, tan, or yellow, and if the plug was used with unleaded gas, normal color will b a shade of gray.

C. An insulator that has turned chalk white indicates overheating, and an insulator that is blistered, especially with an eroded or melted electrode, indicates extreme overheating.

D. Overheating may mean ignition timing is advanced too far, the air/fuel mixture is too lean, coolant or air flow problems over the cooling fins, or a spark plug with too high a heat range.

INFORMATION SHEET

E. When electrodes and the insulator nose are black and fouled, it often means the spark plug operating temperature is too low to burn off carbon deposits or that fuel or oil in the combustion chamber is leaving excessive carbon deposits.

F. Dry, sooty fouling may indicate excessive choke use, long periods of idling or low rpm operations, an air/fuel mixture far too rich, or a spark plug heat range too low.

G. Wet, oily black fouling indicates engine wear or damage to piston or piston rings, or too much oil in the fuel/oil mixture.

H. When spark plug wear indicates other problems, the other problems should also be corrected when the spark plugs are replaced.

XII. **Recoil starter service** (Transparency 3)

A. Electic starting systems are becoming more common on snowmobiles, but some operators still prefer a recoil starter because they require virtually no maintenance.

B. Recoil starter problems vary with the frequency and manner in which they are used, but generally recoil starter ropes break and have to be replaced or the springs wear out or break and have to be replaced.

C. Recoil starters are not complex, but it takes patience and practice to service one properly, and owners who attempt the job themselves frequently take the mess of unwound springs and other parts to someone who knows how it should be done.

(NOTE: Job Sheet #5 outlines recoil starter repair the way it should be done.)

XIII. **Servicing the electrical system**

A. The electrical system on a typical snowmobile consists of:

1. Voltage regulator
2. Headlight and headlight dimmer switch
3. Brakelight and brakelight switch
4. Speedometer/tachometer
5. Key switch
6. Emergency stop switch

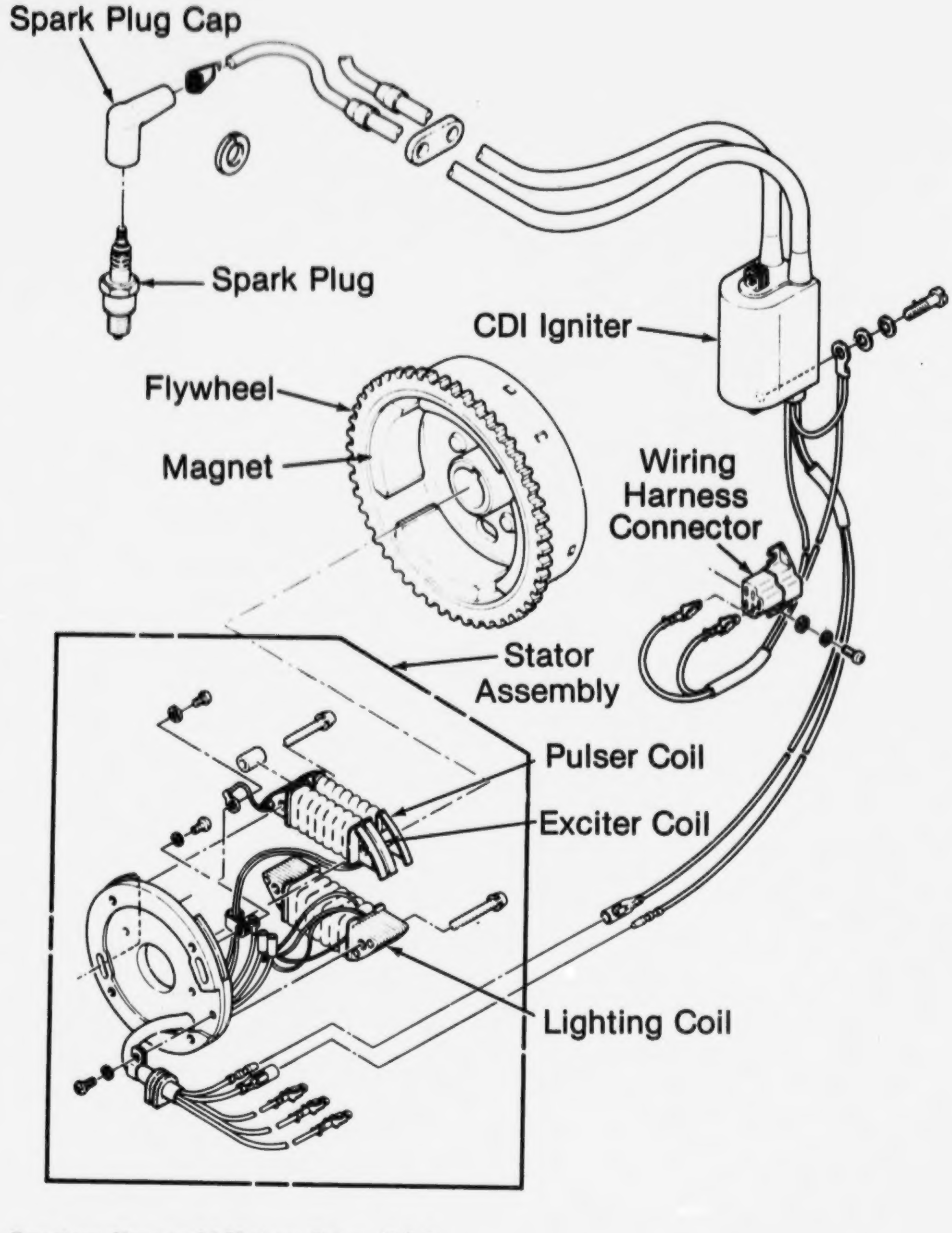
INFORMATION SHEET

B. Although some ignition testing requires special instruments, most of the components in the electrical system can be tested with a multimeter that will measure AC and DC voltages and resistance in ohms.

C. Electrical system troubleshooting should be systematic so that potential trouble spots can be quickly eliminated in a logical order before going on to problems that require more time.

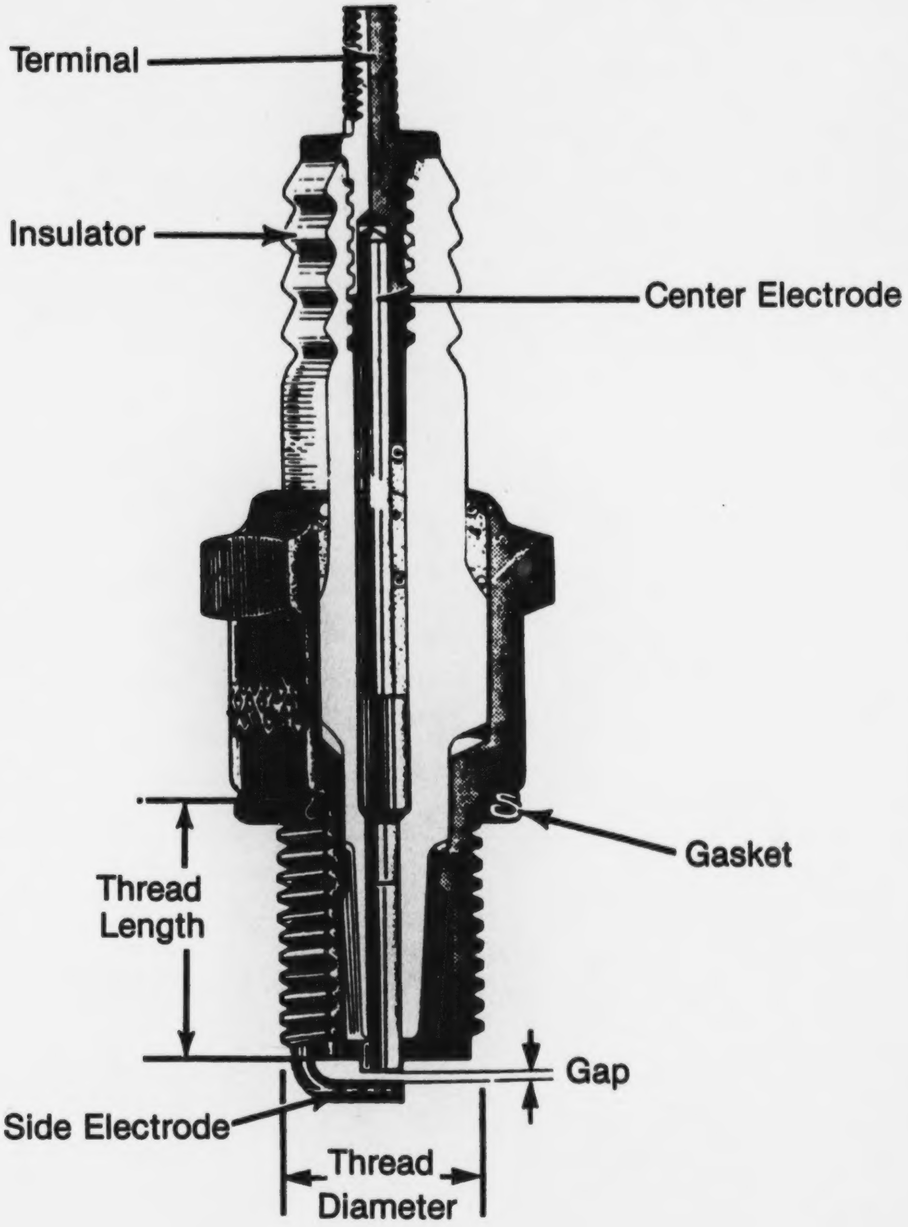
Example: Intermittent spark or no spark at all may be caused by a faulty ground wire which can be checked in about two minutes.

Capacitor Discharge Ignition System

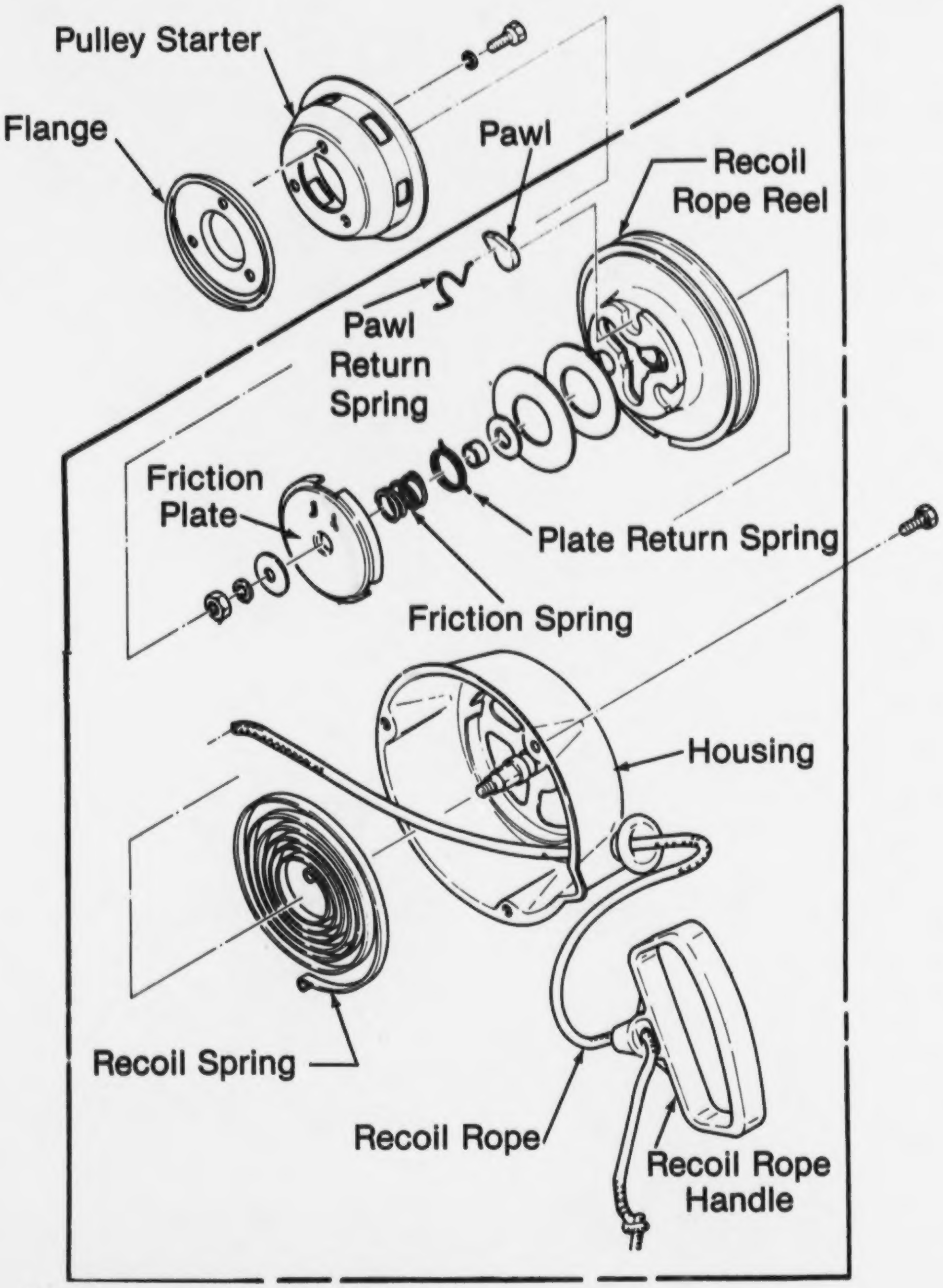

Spark Plug Cap
Spark Plug
CDI Igniter
Flywheel
Magnet
Wiring Harness Connector
Stator Assembly
Pulser Coil
Exciter Coil
Lighting Coil

Courtesy Kawasaki Motors Corp., U.S.A.

Parts of a Spark Plug


Terminal
Insulator
Center Electrode
Gasket
Thread Length
Gap
Side Electrode
Thread Diameter

Components of a Recoil Starter


Pulley Starter
Flange
Pawl
Recoil Rope Reel
Pawl Return Spring
Friction Plate
Plate Return Spring
Friction Spring
Housing
Recoil Spring
Recoil Rope
Recoil Rope Handle

Courtesy Kawasaki Motors Corp., U.S.A.

IGNITION AND ELECTRICAL SYSTEMS
UNIT XIII

JOB SHEET #1 — REMOVE, INSPECT, SERVICE, AND REPLACE A SNOWMOBILE BATTERY

A. Tools and materials

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Basic hand tools
4. Clean shop towels
5. Soda for cleaning
6. Wire brush
7. Hydrometer
8. Battery charger
9. Distilled water
10. Small funnel
11. Safety glasses

B. Routine #1 — Removing the battery

1. Put on safety glasses.
2. Secure the sled and make sure the ignition is off.
3. Remove equipment as required to reach the battery compartment, and note how the vent tube is routed.
4. Remove the negative cable from the battery post.
5. Remove the positive cable from the battery post.
6. Remove support brackets, and take battery from the snowmobile.
7. Place the battery in a well ventilated area away from any flammables or open flames.

☐ Have your instructor check your work

JOB SHEET #1

C. Routine #2 — Cleaning and inspecting the battery

1. Put on safety glasses.

2. Check the battery case to see if it is cracked or badly worn, and if it is, it should be replaced.

   (NOTE: Make the overall inspection first because there is no need to waste time cleaning a battery that has to be replaced.)

3. Wash the battery off with water and dry it with a shop towel so you can see into the battery.

4. Look at the battery cells carefully to see if there is a whitish build-up between the plates or if the plates appear to be corroded, and if such wear is present, the battery should be replaced.

5. Check for the presence of a whitish color around cells; if the whitish color is present, it indicates sulfation, and even if sulfation is present on only one cell, the battery should be replaced.

6. Inspect the case again for hairline cracks that would indicate the battery has been frozen, and if cracks are present, the battery should be replaced.

7. Wash the battery posts with a soda solution, dry them, then clean them with a wire brush.

8. Inspect the battery posts to see if there is damage from corrosion or cracks caused by overtightening, and if there is severe damage such as a loose post, the battery should be replaced.

☐ Have your instructor check your work

D. Routine #3 — Servicing the battery

1. Leave your safety glasses on.

2. Remove the filler caps from the battery.

3. Top off each cell with the right amount of distilled water, and be sure not to overfill the cells.

4. Replace the filler caps.

5. Make sure the battery charger is OFF, and hook the battery up to the charger, positive cable first, negative cable last.

   (NOTE: Even though the battery charger is off, develop the habit of always removing the negative cable first and the positive cable last, and installing the positive cable first and negative cable last when working around any battery.)

6. Check the battery ampere-hour rating on the battery case, and charge the battery at a rate of 10% of that rating. A higher charge rate could damage the battery.

JOB SHEET #1

7. Turn the battery charger OFF, and disconnect the cables, negative first, positive last.

8. Remove the filler caps from the battery cells.

9. Use the hydrometer to draw electrolyte samples from each cell, and record your findings on the Battery Service Log that accompanies this job sheet.

10. Evaluate your hydrometer readings according to the following:

    a. If specific gravity readings are within the range of 1.260 to 1.280, it indicates a fully charged battery.

    b. If the readings from cell to cell vary more than .025, it usually means there is internal battery deterioration and the battery should be replaced.

    c. If the readings are less than 1.260, it indicates the battery needs charging.

11. Replace the filler caps.

12. Check the battery ampere-hour rating on the battery case, and charge the battery at a rate of 10% of that rating.

13. Check the manufacture date on the battery and charge accordingly:

    a. If the battery is less than 12 months old, charge 3 hours.

    b. If the battery is 12 to 18 months old, charge 5 hours.

    c. If the battery is 18 to 24 months old, charge 10 hours.

    d. If the battery is more than 23 months old, charge 15 to 20 hours.

☐ Have your instructor check your work

E. Routine #4 — Making a battery voltage test

1. Put on safety glasses.

2. Set your multimeter to test DC voltage at 20V or 25V.

   (NOTE: Sometimes a hydrometer test will show that a battery has proper specific gravity, but the battery may still be the problem; this test is the best way to double check the battery and also find out if the starter or cranking motor is the cause of the problem.)

3. Make sure filler caps are all in place.

4. Place the red test lead from the test meter onto the positive (+) battery terminal.

JOB SHEET #1

5. Place the black test lead from the test meter onto the negative (−) battery terminal.

6. Check the meter for a reading of 11 to 13 volts.

7. Watch your meter as you crank the engine for about 15 seconds.

    a. If the meter drops to 9 volts or less while cranking the engine, the problem is likely to be in the starter (cranking motor).

    b. If the meter reading remains at 11 to 13 volts about 15 seconds after the cranking test, the battery is okay.

    c. If the meter reading is lower than 11 volts after the cranking test, the battery should be replaced.

8. Recommend putting the battery back in place or replacing it according to your findings.

☐ Have your instructor check your work

F. Routine #5 — Replacing the battery

1. Put on safety glasses.

2. Clean the battery compartment.

3. Check all battery cable connections to chassis ground and to the starting motor, and clean and tighten as needed.

4. Coat the battery posts with light oil or petroleum jelly.

5. Put the battery in place and secure the support brackets.

6. Make sure the vent tube is in place and properly routed.

7. Replace and tighten the positive cable first, and then replace the negative cable.

8. Replace any equipment removed to reach the starter.

☐ Have your instructor check your work

9. Clean up area and return tools and materials to proper storage.

IGNITION AND ELECTRICAL SYSTEMS
UNIT XIII

JOB SHEET #2 — REMOVE AND INSPECT IGNITION COIL LEADS

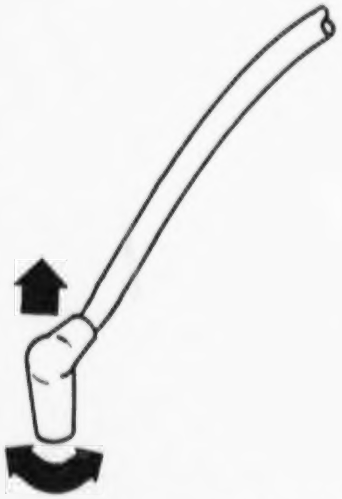
A. Tools and materials

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Basic hand tools
4. Replacement spark plugs as required
5. Safety glasses

B. Procedure

1. Put on safety glasses.
2. Make sure the ignition is off.
3. Remove the first spark plug cap by twisting the cap back and forth and pulling straight upward, but do not twist or pull directly on the lead wire because you could damage the connection. (Figure 1)

FIGURE 1



Courtesy Kawasaki Motors Corp., U.S.A.

JOB SHEET #2

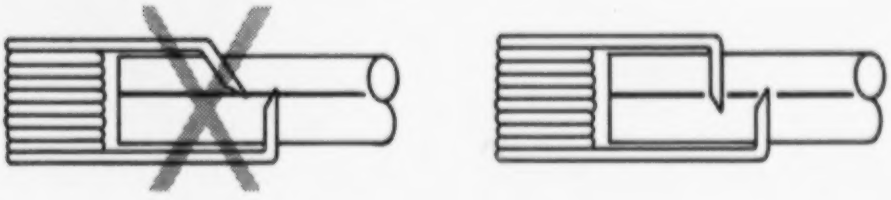
4. Check the spring terminal for correct installation on the ignition coil lead.

   (NOTE: This spring terminal inside the spark plug cap can be the cause of ignition system malfunction if it has been improperly installed or carelessly removed.)

5. Slide the cap off the lead wire.

6. Check to make sure that the spring terminals are at a 90° angle to insure proper engagement with the inner coil wire. (Figure 2)

   FIGURE 2

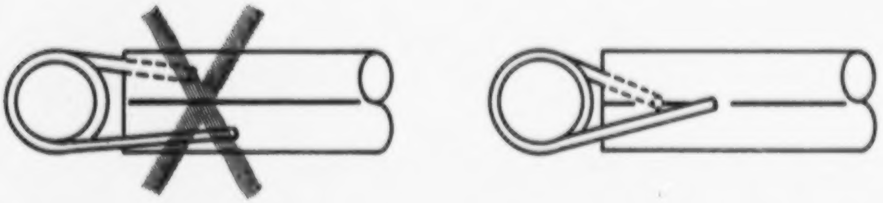


Incorrect Correct

Courtesy Kawasaki Motors Corp., U.S.A.

7. Check to make sure that both arms of the spring terminal enter the ignition coil lead at its centerline to insure contact with the inner wire. (Figure 3)

   FIGURE 3



Incorrect Correct

Courtesy Kawasaki Motors Corp., U.S.A.

JOB SHEET #2

8. Correct spring terminal problems as required.

☐ Have your instructor check your work

9. Slide the spark plug cap back onto the ignition coil lead so that it properly covers the spring terminal.

10. Clean up area and return tools and materials to proper storage.

IGNITION AND ELECTRICAL SYSTEMS
UNIT XIII

JOB SHEET #3 — REMOVE, INSPECT, AND TEST SPARKS PLUGS

A. Tools and materials

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Basic hand tools
4. Wire brush
5. Compressed air supply
6. Clean shop towels
7. Spark plug tester
8. Replacement spark plugs as required
9. Safety glasses

B. Routine #1 — Removing and cleaning the spark plugs

1. Put on safety glasses.
2. Use compressed air to clean the area around the spark plugs.
3. Loosen the spark plugs one full turn, then clean the spark plug area with compressed air again to remove bits of dirt released from the spark plug threads.
4. Remove both plugs and inspect them for signs of electrode wear, discoloration that would indicate other engine or timing problems, and for sooty or oily fouling.
5. Check the electrode gap with a feeler gauge.

(NOTE: It is not recommended to use sand-blast type abrasive spark plug cleaners. Some manufacturers will void the warranty on their engine if a sand -blasted spark plug is installed in it. It has been shown that it is difficult to remove all of the sand in the plug and an engine can be ruined by only a little sand.

JOB SHEET #3

6. Clean the threads with a wire brush. (Figure 1)

FIGURE 1

☐ Have your instructor check your work

7. Recommend replacement plugs or reuse the old plugs according to your inspection results.

C. Routine #2 — Checking for proper spark

1. Put on safety glasses.

2. Place both spark plugs on the engine and make sure they are grounded to the engine. (Figure 2)

FIGURE 2

JOB SHEET #3

3. Crank the engine and observe the spark across the spark plug electrodes.

   a. If a blue spark jumps the electrode gap, it indicates the ignition system should start and run the engine if timing is correct.

   b. If there is no spark or a weak spark, the system will require more troubleshooting as outlined in the next routine.

   (NOTE: If the spark cannot be observed, test plugs can be made by removing the ground electrodes from a set of like spark plugs; this increases the distance the spark will have to jump from center electrode to ground, works the ignition system harder, and should provide a spark that can be easily observed; ask your instructor about spark plugs and whether or not you should use them.)

☐ Have your instructor check your work

D. Routine #3 — Checking for proper spark

1. Put on safety glasses.
2. Remove the cap from one of the spark plugs.
3. Install a spark tester into the spark plug cap.
4. Make sure the spark tester has a good ground to the engine. (Figure 3)

FIGURE 3

JOB SHEET #3

5. Crank the engine one or two turns.

   (CAUTION: Do not touch the spark tester as you are conducting this test because the high voltage can produce a severe shock.)

6. Observe the spark across the tester.

   a. If the spark jumps the gap in the tester, the ignition system is okay and the spark plugs need to be replaced.

   b. If there is no spark through the tester, the problem is elsewhere in the ignition system and will require further troubleshooting.

7. Remove the spark tester.

☐ Have your instructor check your work

8. Replace old plugs or install new plugs.

9. Clean up area and return tools and materials to proper storage.

IGNITION AND ELECTRICAL SYSTEMS
UNIT XIII

JOB SHEET #4 — TROUBLESHOOT A SNOWMOBILE ELECTRICAL SYSTEM

A. Tools and materials

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Basic hand tools
4. Multitester
5. Safety glasses

B. Routine #1 — Troubleshooting the stop circuit

1. Put on safety glasses.

   (NOTE: It's easy to waste time with ignition problems if you perform elaborate troubleshooting first; the routines that follow show you how to do the easy routines first so you will save time.)

2. Check for good spark plugs and proper spark as outlined in a previous job sheet.
3. Trace the key switch and emergency stop switch circuits to the wiring harness connector on the engine.
4. Remove the key switch and emergency stop switch circuits from the system.
5. Make sure the sled is properly secured so the engine can be started.
6. Crank the engine.
   a. If spark occurs with the key switch and emergency stop circuits disconnected, the ignition components on the engine are okay, and the key switch, emergency stop switch, or the wiring (or a combination of these) is probably defective.
   b. If there is no spark at all, test ignition components mounted on the engine.

☐ Have your instructor check your work

C. Routine #2 — Troubleshooting the ground wire

1. Put on safety glasses.

JOB SHEET #4

2. Check the ground wire connections at the main engine terminals to make sure they are in good shape and securely mounted.

   (NOTE: A loose ground wire connection can be the cause of an intermittent spark, and a broken connection will result in no spark at all.)

3. Find the ground wire between the terminal on the engine and the terminal on the primary of the ignition coil.

   (NOTE: Check your wiring schematic or ask your instructor for help if you have trouble finding the proper ground wire.)

4. Remove the screws that secure the ground wire at all terminals.

5. Set the multimeter to read ohms on the lowest scale.

6. Connect one ohmmeter lead to the terminal end of the ground wire that you removed from the ignition coil.

7. Connect the other ohmmeter lead to the terminal end of the ground wire that you removed from the engine.

   a. If the ohmmeter shows a 0 to indicate a closed circuit, the ground wire between the engine and the ignition coil is okay.

   b. If the ohmmeter shows ∞ to indicate an open circuit or high resistance, the ground wire is defective and should be replaced.

8. Find the ground wire between the CD igniter and the ignition coil And check it with the procedure previously outlined.

   a. If the wire is not okay, replace it and test again.

   b. If the wire is okay, then the DC igniter is malfunctioning and should be replaced.

☐ Have your instructor check your work

D. Routine #3 — Troubleshooting the key switch

1. Put on safety glasses.

2. Remove components as required to gain access to the terminals on the key switch.

3. Remove the main wiring harness connector from the key switch terminals.

4. Set the multitester to read ohms on the X100 scale.

JOB SHEET #4

5. Check the manufacturer's schematic to determine which terminals control the RUN and OFF circuit of the ignition system and which terminals control the lights and accessories.

6. Connect one ohmmeter lead to one terminal of the RUN/OFF circuit and the other ohmmeter lead to the other terminal of the RUN/OFF circuit.

7. Turn the key switch to the OFF position and watch the ohmmeter for a reading of 0 to indicate a closed circuit, and if the ohmmeter does not move to 0, replace the key switch.

8. Set the ohmmeter scale on XI and connect one ohmmeter lead to one of the light circuit terminals on the key switch and the other ohmmeter lead to the other light circuit terminal.

9. Turn the key switch to the RUN/LIGHTS position and watch the ohmmeter for a reading of 0 to indicate a closed circuit, and if the ohmmeter does not move to 0, replace the key switch.

10. Leave test leads connected and turn the key switch to the RUN or OFF position and look for a ∞ to indicate an open circuit, and if the ∞ is not there, replace the key switch.

E. Routine #4 — Troubleshooting the emergency stop switch

1. Put on safety glasses.

2. Disconnect the connector between the key switch and the emergency stop switch.

3. Set the multimeter to read ohms on the X100 scale.

4. Connect one ohmmeter lead to one terminal in the stop switch half of the connector and the other ohmmeter lead to the other terminal in the stop switch half of the connector.

5. Turn the stop switch to the ON position, and watch the ohmmeter for a reading of ∞ which indicates an open circuit, and if the needle moves off the ∞ reading, replace the stop switch.

6. Turn the stop switch to the STOP position and watch the ohmmeter for a reading of 0 to indicate a closed circuit, and if the needle does not indicate 0, replace the emergency stop switch.

☐ Have your instructor check your work

7. Replace the old switch or put in a new switch as required and reconnect the connector.

JOB SHEET #4

F. Routine #5 — Troubleshooting the voltage regulator

1. Put on safety glasses.

2. Raise the rear of the sled and make sure the track can be safely rotated.

   (CAUTION: Place the ski tips against a stationary object to insure the sled cannot move.)

3. Set the multimeter to read 25 volts AC.

   (NOTE: The following tests should always be conducted if bulbs consistently burn out or if the lights are too dim, and remember that melted filaments in a bulb indicate over-voltage out of the regulator, and broken filaments indicate vibration or other problems.)

4. Attach one test lead to one of the wires in the main harness half of the engine connector, and the other lead to the other wire, but be sure you are not putting either lead on the ground wire.

   (NOTE: Check a schematic to be sure, but both wires should be the same color, and the ground wire will be a different color.)

5. Turn the key switch to the RUN position, start the engine, and allow it to idle but do not run it over 2,000 RPM, and do not activate the brake light during the voltage regulator test.

6. Watch the needle on the test meter for a reading of 8 to 11 volts which will indicate that the lighting coil and the voltage regulator are both okay.

   a. If the reading is less than 8 volts go on to Step 8.

   b. If the reading is more than 11 volts, go on to Step 7.

7. Increase the engine RPM slowly, but do not exceed 3,000 RPM, and if the voltage reading doesn't stabilize at 8 to 11 volts, or if the voltage exceeded 22 volts, the voltage regulator should be replaced.

8. Disconnect the voltage regulator from the main wiring harness while the engine is running at about 2,000 RPM, and watch for the meter needle to move to somewhere between 14 and 20 volts.

   a. If the voltage does not increase, the problem is in the magneto lighting coil circuit.

   b. If the voltage does increase, it could mean a shorted voltage regulator, a shorted tachometer, or a short in the main harness wiring.

JOB SHEET #4

9. Unplug the tachometer connector from the main wiring harness and repeat the test to confirm whether it is or is not a tachometer short.

10. Replace or repair the main wiring harness to determine if the wiring harness is the source of the trouble.

11. Replace the voltage regulator if it is shorted, and be sure the connection to the main harness is good and tight and that the regulator case is properly grounded.

☐ Have your instructor check your work

12. Clean up area and return tools and materials to proper storage.

IGNITION AND ELECTRICAL SYSTEMS
UNIT XIII

JOB SHEET #5 — SERVICE A RECOIL STARTER

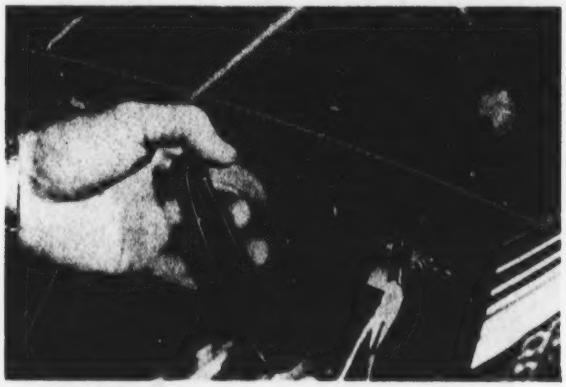
A. Tools and materials

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Basic hand tools
4. Clean shop towels
5. Match or lighter
6. Piece of wire
7. Clamp
8. Torque wrench
9. Safety glasses

B. Routine #1 — Removing the starter and replacing the rope

1. Put on safety glasses.
2. Untie the knot in the pull handle, remove the handle from the rope, and tie the knot back onto the end of the rope to prevent the rope from suddenly retracting into the recoil case. (Figure 1)

FIGURE 1



JOB SHEET #5

3. Remove the muffler, if required, for access to the recoil starter.

4. Remove the starter cover bolts and remove the rewind unit from the sled. (Figure 2)

FIGURE 2

5. Place the starter on a clean work table. (Figure 3)

FIGURE 3

JOB SHEET #5

6. Remove the center nut or snap-ring. (Figure 4)

FIGURE 4

7. Remove the starter pawl cover, the starter pawls, and the spring. (Figure 5)

FIGURE 5

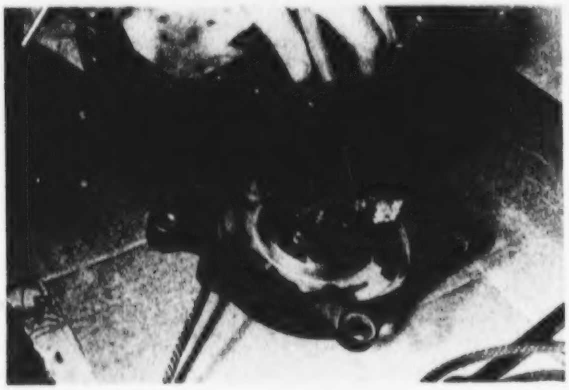
JOB SHEET #5

8. Pull the rope all the way out.

9. Secure the rope wind wheel with a clamp. (Figure 6)

10. Use needlenose pliers to grab the knot inside the housing, and pull the rope free of the assembly. (Figure 6)

FIGURE 6



11. Singe the end of the replacement rope with the flame from a match or a lighter. (Figure 7)

FIGURE 7

JOB SHEET #5

12. Work a piece of wire through the prepared end of the rope to service as a guide. (Figure 8)

FIGURE 8

13. Feed the wire leader and the rope back through the rope wind wheel from the inside to the outside. (Figure 9)

FIGURE 9

JOB SHEET #5

14. Roll a double knot around the other end of the rope by wrapping the rope twice around the end of your index finger and then pulling the free end of the rope through the open area left when you remove your finger. (Figure 10)

FIGURE 10

15. Pull the knot into the assembly and work the knot down inside.

16. Tie a knot in the other end of the rope so that the rope won't slip back through the housing as you rewind the rope.

17. Loosen the clamp to permit the rope to naturally rewind itself.

☐ Have your instructor check your work

(NOTE: If you were only replacing a rope, the starter could be reinstalled at this point, but to replace a broken spring or inspect for other interior damage, continue with the next routine which also includes rope replacement.)

C. Routine #2 — Replacing the starter spring

1. Put on safety glasses.

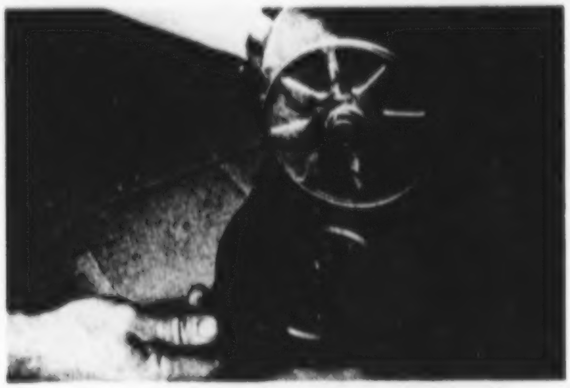
JOB SHEET #5

2. Release the clamp and allow the spring to unwind all the way. (Figure 11)

FIGURE 11

3. Lift the rope wheel off of the assembly. (Figure 12)

FIGURE 12



JOB SHEET #5

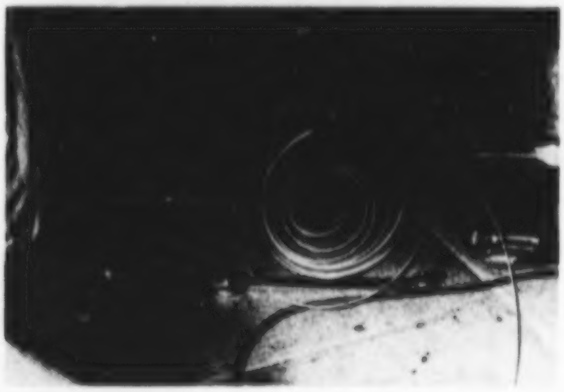
4. Grasp the complete spring in one place with a pair of vise-grips and remove the spring from the assembly. (Figure 13)

FIGURE 13

5. Replace the spring if it is broken, or recoil it if not properly coiled.

6. Put on a pair of gloves to rewind the spring, and rewind it carefully by hand. (Figure 14)

FIGURE 14



JOB SHEET #5

7. Hold the rewound spring in place with pliers as you reinstall the spring in the housing, and be sure you put the spring in the right way so the spring tension will wind tight as the rope is pulled out. (Figure 15)

FIGURE 15

8. Release the pliers and permit the spring to rewind.
9. Install the rope wheel into the housing and rotate it in the same direction the rope will pull until the spring tension becomes tight, and this usually takes 12 to 15 full turns.
10. Clamp the assembly in place once again.
11. Replace the rope as previously outlined.
12. Release the clamp and permit the rope to rewind.
13. Inspect the pawls for cracks or wear and replace them with new ones if required.
14. Replace the pawls.

JOB SHEET #5

15. Reinstall the cover return spring, and then slip the cover back into place so that the spring fits into the slot in the cover. (Figure 16)

FIGURE 16

16. Wind the cover back one-third of a turn.

17. Put the washer and cap nut back in place and torque to specifications.

18. Pull the rope a few times to check for proper pull and recoil action, and check to make sure the pawls move into place as you pull the rope.

☐ Have your instructor check your work

19. Reinstall the recoil starter on the snowmobile, and test the starter on the sled.

20. Replace any components removed to gain access to the starter.

21. Clean up area and return tools and materials to proper storage.

IGNITION AND ELECTRICAL SYSTEMS
UNIT XIII

NAME ______________________

TEST

1. Match the terms on the right with their correct definitions.

_____a. Electric current which reverses its direction of flow at regular intervals

_____b. Electric current which flows in only one direction

_____c. The unit of measurement for current flow

_____d. The unit of measurement of electrical pressure

_____e. The unit of measurement of resistance to electrical flow

_____f. A generator which produce alternating current

_____g. A device capable of storing limited amounts of electrical power for discharge at a predetermined time or on a predetermined signal

_____h. A device that changes alternating current into direct current

_____i. The process of changing an object by bringing it into the magnetic field of an electromagnet or permanent magnet

1. Ohm
2. Induction
3. Alternator
4. Alternating current
5. Rectifier
6. Ampere
7. Direct current
8. Capacitor
9. Volt

2. Select true statements concerning snowmobile electrical requirements by placing an "X" beside each statement that is true.

(NOTE: For a statement to be true, all parts of the statement must be true.)

_____a. The three basic electrical needs on a snowmobile are:

1) An ignition system to start the engine

2) An electrical system to operate lights

3) An alternator to operate accessories

TEST

_____b. Starting a snowmobile engine can be accomplished with a battery-based electric start unit or with a recoil starter that is manually operated.

_____c. Electrical demands for ignition and for lighting and accessories are two separate functions, and although the two systems are related, they operate as individual systems.

_____d. An ignition system produces high voltage required to jump the gap of the spark plug electrodes and ignite the air/fuel mixture in the combustion chamber of the engine.

_____e. Lower voltage alternating current is used for lights and accessories, and AC output is stabilized through a voltage regulator.

3. Complete a statement concerning battery ignition systems by inserting the word(s) or figure(s) that best completes each statement.

a. Battery ignition systems are found mostly on ____________ sleds.

b. In a battery ignition system, the battery supplies electrical current to the starter or cranking motor which is a ____________ motor that works with brushes and a commutator.

c. The battery supplies power for the primary ignition circuit, and timing is accomplished with ____________ ____________ and a condenser.

d. When ____________ ____________ are replaced in this type system, the condenser should also be replaced.

e. A battery ignition system may produce up to 10,000 volts to fire the spark plugs, and ____________ electricity for lights and accessories are on a separate circuit.

f. Alternator output is also used to ____________ ____________ ____________.

g. Cranking motors or starters should not be operated continuously for more than ____________ seconds, and a cool-down period of 30 seconds or more should be observed at starting intervals.

h. Demands of cold weather, vibration, and frequent stopping/starting require that batteries be inspected frequently for proper electrolyte level, corrosion-free connections, and proper ____________.

TEST

4. Solve the following problems concerning battery service.

   a. What is the very first step in all battery service?

   Answer ______________________________

   b. Which cable should be removed first when performing battery service and when should it be replaced?

   Answer ______________________________

   c. Name at least two times when a battery should be inspected.

   Answer ______________________________

5. Select true statements concerning magneto ignition systems by placing an "X" beside each statement that is true.

   _____a. Magneto ignition systems use rotating magnets to induce current in the primary ignition circuit.

   _____b. Magneto ignition systems are energy transfer systems, accomplish timing with breaker points and a condenser, and are serviced like other breaker point/condenser systems.

   _____c. A magneto ignition system may produce up to 10,000 volts to fire the spark plugs, and uses an alternator to provide AC electricity for lights and accessories.

6. Complete statements concerning capacitor discharge systems by inserting the word(s) or figure(s) that best completes each statement.

   a. Capacitor discharge ignitions systems are the most __________ ignition systems found on modern snowmobiles.

   b. CDI systems are popular because they do not use __________ __________ and are easy to service.

   c. CDI systems use rotating magnets to induce current into a __________ which stores the current until another impulse causes the __________ to discharge and fire the spark plugs.

   d. A CDI system may produce as high as __________ volts to fire the spark plugs, and this gives the CDI system an extra punch that also makes it more popular than other ignition systems.

   e. A CDI system has a lighting coil to provide AC electricity to the __________ __________ for operating lights and accessories.

TEST

7. Match components with their functions in a CDI system.

_____a. Houses four permanent magnets which provide a moving magnetic field as the flywheel rotates around the coils in the stator assembly.

_____b. Houses the exciter, pulsing, and lighting coils.

_____c. Charges the capacitor in the CDI igniter.

_____d. Signals the capacitor in the CDI igniter when to release its charge to the ignition coil.

_____e. A coil with primary and secondary windings that induce the high voltage needed to jump the air gap on the spark plugs.

_____f. Provides alternating current for the lights and instruments in the electrical system.

1. Ignition coil
2. Lighting coil
3. Flywheel
4. Pulser coil
5. Stator assembly
6. Exciter coil

8. Complete statements concerning CDI operations by inserting the word(s) that best completes each statement.

a. As the flywheel rotates, alternating current is induced in the _____________ mounted on the stator.

b. The coil sends a charge to the capacitor which stores the charge, and the amount of charge the _____________ coil gives the capacitor affects the intensity of the spark.

c. The _____________ coil causes the capacitor in the CDI igniter to release its stored energy, but the _____________ coil is only a signaling device and it has no affect on the intensity of the spark.

d. The primary winding in the _____________ coil induces a high voltage in the secondary winding of the _____________ coil, and causes a spark to jump across the spark plug electrodes.

e. The ignition coil fires high voltage charges to the spark plugs _____________ each time the flywheel makes one complete rotation.

TEST

9. Complete statements concerning safety features in a CDI system by inserting the word(s) that best completes each statement.

   a. For both safety and ____________, a snowmobile engine needs to stop and start at the turn of a switch, but the sled also needs to stop if the rider should lose control and fall off.

   b. The ____________ ____________ on a snowmobile permits the engine to be started or stopped with the turn of a key and services both safety and convenience.

   c. The ____________ ____________ ____________ is strictly a safety device that will stop the engine if the rider is thrown off and the throttle handle is suddenly released.

   d. Together, the ____________ ____________ and ____________ ____________ ____________ function to protect both the sled and the rider, and they are both connected to CDI igniter leads.

   e. The two switches work independently of each other, and when either switch is positioned to ____________, all charging to the capacitor stops, there can be no charge transmitted from the igniter coil to the spark plugs, and the sled stops.

   f. The ____________ ____________ and ____________ ____________ ____________ should never be ____________, and a sled with problems in either of these circuits should not be used until the problems are corrected.

10. Solve problems concerning spark plug service.

    a. Why should the engine area around a spark plug be cleaned before the plug is removed?

       Answer ____

       ____

    b. A replacement spark plug should be the same size as the original, but what other requirement must a replacement plug meet?

       Answer ____

       ____

11. Complete statements concerning how to use spark plug wear as troubleshooting guidelines by inserting the word(s) that best completes each statement.

    a. Discoloration and ____________ are two ways that the condition of a spark plug can reflect other operating conditions that need attention.

    b. After service, a spark plug used with regular gas will be a shade of ____________, tan or yellow, and if the plug was used with unleaded gas, normal color will be a shade of ____________.

TEST

c. An insulator that has turned __________ __________ indicates overheating, and an insulator that is blistered, especially with an eroded or melted electrode, indicates __________ overheating.

d. Overheating may mean ignition timing is advanced too far, the air/fuel mixture is too lean, coolant or air flow problems over the cooling fins, or a spark plug with __________ __________ a heat range.

e. When electrodes and the insulator nose are black and fouled, it often means the spark plug operating temperature is __________ __________ to burn off carbon deposits or that fuel or oil in the combustion chamber is leaving excessive carbon deposits.

f. Dry, sooty foulings may indicate excessive __________ use, long periods of idling or __________ RPM operations, and air/fuel mixture far too rich, or a spark plug heat range too low.

g. Wet, oily black fouling indicates engine wear or damage to __________ or __________ __________, or too much oil in the fuel/oil mixture.

h. When spark plug wear indicates other problems, the other problems should also be __________ when the spark plugs are replaced.

12. Select true statements concerning recoil starter service by placing an "X" beside each statement that is true.

_____a. Electric starting systems are becoming more common on snowmobiles, but some operators still prefer a recoil starter because they require virtually no maintenance.

_____b. Recoil starter problems vary with the frequency and manner in which they are used, but generally recoil starter ropes break and have to be replaced or the springs wear out or break and have to be replaced.

_____c. Recoil starters are not complex, but it takes patience and practice to service one properly, and owners who attempt the job themselves frequently take the mess of unwound springs and other parts to someone who knows how it should be done.

13. Complete the statements concerning the electrical system by inserting the word(s) that best completes each statement.

a. The electrical system on a typical snowmobile consists of:

1) Voltage __________

2) Headlight and headlight dimmer __________

3) Brakelight and brakelight __________

4) Speedometer/__________

5) __________ switch

6) __________ switch

TEST

b. Although some ignition testing requires special instruments, most of the components in the electrical system can be tested with a multimeter that will measure ____________ and ____________ voltages and ____________ in ohms.

c. Electrical system troubleshooting should be ____________ so that potential trouble spots can be quickly eliminated in a logical order before going on to problems that require more time.

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

14. Demonstrate the ability to:

    a. Remove, inspect, service, and replace a snowmobile battery. (Job Sheet #1)

    b. Remove and inspect ignition coil leads. (Job Sheet #3)

    c. Remove, inspect, and test spark plugs. (Job Sheet #3)

    d. Troubleshoot a snowmobile electrical system. (Job Sheet #4)

    e. Service a recoil starter. (Job Sheet #5)

IGNITION AND ELECTRICAL SYSTEMS
UNIT XIII

ANSWERS TO TEST

1. a. 4
   b. 7
   c. 6
   d. 9
   e. 1
   f. 3
   g. 8
   h. 5
   i. 2

2. b, c, d, e

3. a. Older
   b. DC
   c. Breaker points
   d. Breaker points
   e. AC
   f. Charge the battery
   g. 30
   h. Venting

4. a. Put on safety glasses.
   b. Remove the negative cable first, replace it last
   c. After long periods of storage or after the sled has been subjected to high vibrations

5. a, b, c

6. a. Common
   b. Breaker points
   c. Capacitor, capacitor
   d. 40,000
   e. Voltage regulator

7. a. 3
   b. 5
   c. 6
   d. 4
   e. 1
   f. 2

8. a. Coils
   b. Exciter, exciter
   c. Pulser, pulser
   d. Ignition, ignition
   e. Twice

ANSWERS TO TEST

9. a. Convenience
   b. Key switch
   c. Emergency stop switch
   d. Key switch, emergency stop switch
   e. STOP
   f. Key switch, emergency stop switch, altered

10. a. To keep dirt or debris from falling in the combustion chamber
    b. It must have the proper heat range

11. a. Fouling
    b. Brown, gray
    c. Chalk white, extreme
    d. Too high
    e. Too low
    f. Choke, low
    g. Piston, piston rings
    h. Corrected

12. a, b, c

13. a. 1) Regulator
       2) Switch
       3) Switch
       4) Tachometer
       5) Key
       6) Emergency stop
    b. AC, DC, resistance
    c. Systematic

14. Performance skills evaluated according to procedures written in the job sheets

WE STORE
CARS • BOATS
CAMPERS • SNOWMOBILES etc.

STORAGE
UNIT XIV

UNIT OBJECTIVE

After completion of this unit, the student should be able to discuss procedures for storing a snowmobile and removing a snowmobile from storage. The student should also be able to list commercial products available to aid in storage preparation and be able to prepare a snowmobile for summer storage. These competencies will be evidenced by correctly performing the procedures outlined in the assignment and job sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student will be able to:

1. Match terms related to storage with their correct definitions.
2. Select true statements concerning cleaning.
3. Complete statements concerning engine preparation.
4. Select true statements concerning battery preparation.
5. Select true statements concerning drive drain preparation.
6. Complete statements concerning lubrication and storage.
7. Solve problems related to snowmobile storage. (Assignment Sheet #1)
8. Demonstrate the ability to prepare a snowmobile for summer storage. (Job Sheet #1)

STORAGE
UNIT XIV

SUGGESTED ACTIVITIES

A. Provide students with objective sheet.

B. Provide students with information sheet.

C. Discuss unit and specific objectives.

D. Discuss information sheet.

E. Demonstrate and discuss the procedures outlined in the job sheet.

F. Impress upon students the care that should be exercised when taking a sled out of storage.

G. Give test.

CONTENTS OF THIS UNIT

A. Objective sheet

B. Information sheet

C. Assignment Sheet #1 — Solve Problems Related to Snowmobile Storage

D. Answers to assignment sheet

E. Job Sheet #1 — Prepare a Snowmobile for Summer Storage

F. Test

G. Answers to test

REFERENCES USED IN DEVELOPING THIS UNIT

A. *Chilton's Snowmobile Repair & Tune-Up Guide*, Second edition. Radnor, PA: Chilton Book Co., 1975.

B. *Arctic Cat Service Manual No. 2254-302.* Thief River Falls, MN 56701: ARTCO, Inc., 1984.

C. *1986 Yamaha Snowmobile Mechanics Guide.* Cypress, CA: Yamaha Motor Corporation, U.S.A., 1985.

D. *Kawasaki Drifter Snowmobile Assembly & Preparation Manual.* Santa Ana, CA 92799-5252: Kawasaki Motors Corp., U.S.A., 1980.

STORAGE
UNIT XIV

INFORMATION SHEET

I. **Terms and definitions**

A. Humidity — Moisture in the air

B. Fogging — The process of filling an engine with an oil and air mixture to protect it from corrosion during summer storage

C. Varnishing — The formation of gum in the carburetor from the residue of fuel and oil

D. Polish — A wax product used to give the chassis of a vehicle a high luster and protection from the elements

E. Fuel conditioner — An additive to the fuel/oil mixture which helps protect the engine and internal parts from corrosion

F. Engine corrosion inhibitors — Chemicals sprayed or applied to the internal engine components to protect the engine from rust

II. **Cleaning**

A. Corrosion and rust probably damage more snowmobiles in summer storage than in winter use.

B. Foreign material, dirt, grime, grass, and oil which collects on a snowmobile during winter use can serve to attract and hold humidity which causes rust.

C. An essential procedure to prevent rust during summer storage is to clean the entire snowmobile thoroughly of all foreign material.

D. A thorough washing is required under the seat cushion, in the tunnel, the skid frame, hood and belly pan, as well as the track and suspension system.

(NOTE: Do not allow any water to spill onto the engine or its component parts.)

E. The snowmobile must be allowed to dry thoroughly before storage.

F. Always use an available automotive-type polish, or one recommended by the snowmobile manufacturer, to wax the hood, console, and exterior.

INFORMATION SHEET

III. **Engine preparation**

A. The engine is the part of the snowmobile most vulnerable to damaging corrosion and must be thoroughly protected during summer storage.

B. Manufacturers may differ on whether or not to drain the fuel tank, but the carburetor and fuel pump should be drained.

(NOTE: If the fuel tank is not drained, a fuel stabilizer should be added.)

C. Many manufacturers agree that fogging is necessary to prepare the engine for summer storage.

D. The fogging procedure has been simplified by the production of special fogging sprays which are commercially available.

E. Fogging often causes a fog in the air surrounding the snowmobile, and can be a hazard.

(WARNING: Fogging should always be performed outside where wind can quickly dissipate the fog into the air.)

F. Engine bearings are the most susceptible to the harmful effects of corrosion.

G. A by-product of the ignition of the fuel-oil mixture is water, so manufacturers recommend not starting the engine during summer storage.

H. In addition to fogging, manufacturers recommend that engine corrosion inhibitors be used in the engine as a part of storage preparation.

I. If fogging is not used for preparing the engine for storage, an alternative to fogging is to inject light engine oil into each spark plug hole.

J. When the oil injection method is used, turn the engine over several times to distribute oil throughout the engine and be sure to replace the spark plugs.

IV. **Battery preparation**

A. Before storing a snowmobile, the battery should always be removed from the chassis.

B. Always inspect the electrolyte level in the battery and add distilled water if necessary.

C. Always inspect the terminals of the battery before storage to make certain they are clean and bright.

D. Store the battery in a ventilated area away from flammable materials.

E. Check the battery at intervals to make sure it keeps a full charge.

INFORMATION SHEET

V. Drive train preparation

A. As a preparation for storage, always remove the drive belt and mark the direction of travel.

B. The drive belt should be flat during storage to prevent warpage.

C. As protection against corrosion, some manufacturers recommend that a light oil be lightly applied to steel clutch sheaves, but aluminum sheaves should not be oiled.

(NOTE: Be sure that the sheaves are wiped clean of any oil before use.)

D. The track tension should always be loosened in preparation for storage, and the track should be stored inside on a stand to keep it off the ground.

VI. Lubrication and storage

A. Some manufacturers recommend that a thin film of a light oil be applied to the bottom of skis, ski pivots, and steering spindle bushings.

B. Some manufacturers recommend that synthetic oil be drained from the system and replaced with petroleum-based oil because synthetic oil will not adhere to engine components as well as petroleum-based oils.

C. Make a final inspection of all bolts, nuts, screws and rivets to make certain they are tight.

(NOTE: Always tighten screws, bolts, and nuts to the torquing specifications recommended by the snowmobile manufacturer; all loose rivets should be replaced.)

D. If a snowmobile is stored outdoors during the summer months, it should be completely covered to protect it from dust and moisture.

VII. Removing a snowmobile from storage

A. Fill the fuel tank with fresh fuel.

B. Fill the oil tank with recommended oil.

C. Check chaincase lubricant level.

D. Remove plugs or tape from muffler and air intake silencer.

E. Clean oil from steel sheave faces.

F. Install the drive belt, and it's better to install a new drive belt and use the old one as a spare.

INFORMATION SHEET

G. Inspect all control wires and cables for proper operation.

H. Adjust track to proper tension and alignment.

I. Inspect spark plugs, replace, gap, or clean as required.

(NOTE: After first starting the engine after storage, leave the old spark plugs in awhile so they will collect oil used in storage, and then put in the new plugs.)

J. Start the engine and let the track rotate at low speed.

K. Stop engine and check track alignment and adjust as required.

L. Lower the vehicle from blocks.

STORAGE
UNIT XIV

ASSIGNMENT SHEET #1 — SOLVE PROBLEMS RELATED TO SNOWMOBILE STORAGE

A. A friend who owns a snowmobile argues that he doesn't have enough time to prepare his snowmobile for summer storage, and time is money as far as he is concerned. Why could it be much more expensive for him not to properly prepare his snowmobile for storage?

____

____

B. Why is it so important to clean the snowmobile of dirt, grime, and grass?

____

____

C. What purpose does fogging have in the preparation for summer storage?

____

____

D. What precaution must be taken when performing fogging?

____

____

E. You have no facility for storing your snowmobile indoors. What alternative do you have available?

____

____

STORAGE
UNIT XIV

ANSWERS TO ASSIGNMENT SHEET

A. Improper storage and failure to protect the engine from corrosion during the long storage period could have a very costly effect. Corrosion inside the engine crankcase, especially to bearings, can destroy the engine over time if not corrected. Even if corrected, repairs to a crankcase can cost into the hundreds of dollars.

B. Dirt, grime, grass, and other foreign matter act as collecting agents for moisture in the air. That moisture serves as the agent for producing rust which can destroy the chassis and all metal components of the snowmobile.

C. Fogging provides a protective lubricating coating to the internal parts of the engine and carburetor from the harmful effects of any moisture which could easily be trapped as residue from combustion.

D. Fogging creates a hazardous mist which can enshroud the snowmobile and immediate area. Always perform fog out outdoors where fog can be easily dissipated by winds.

E. The only alternative is to use a heavy tarpaulin or snowmobile cover and to raise the snowmobile off the ground making certain no components of the snowmobile are exposed to rain or dust.

STORAGE
UNIT XIV

JOB SHEET #1 — PREPARE A SNOWMOBILE FOR SUMMER STORAGE

A. Tools and materials

1. Snowmobile as selected by instructor
2. Appropriate service manual
3. Polish, cleaner, and clean rags
4. Engine oil
5. A light petroleum-based oil
6. Spark plug remover
7. Safety stand
8. Fuel stabilizer
9. Engine corrosion inhibitor
10. Chaincase lubricant
11. Safety glasses

B. Procedure

1. Put on safety glasses.
2. Remove the seat cushion from the tunnel and clean it with a damp cloth; store it in a dry place.
3. Wash the snowmobile thoroughly by hosing dirt, oil, grass and other foreign matter from the skid frame, tunnel, hood, and belly pan being very cautious not to get water into any part of the engine.
4. Move the sled outside and drain the fuel tank or add fuel stabilizer if you don't drain the tank.
5. Start the engine and allow it to idle.
6. Spray a two-stroke petroleum-based oil rapidly into the carburetor air intake for up to 20 to 30 seconds or until the engine stops.

   (WARNING: Since this fogging procedure creates a hazardous mist, it should only be performed outdoors.)

JOB SHEET #1

7. Drain carburetor and fuel lines.

8. Plug holes in the muffler and air-intake silencer with clean cloths or tape.

9. Use the following procedure as an alternative to fogging:

   a. Put the ignition key in the "OFF" position, disconnect the high tension wires from the spark plugs and remove the plugs.

   b. Pour an ounce of petroleum-based oil into the spark-plug holes and pull the recoil rope slowly about 10 times.

   c. Reinstall tne spark plugs and connect the high tension wires.

   d. Drain carburetor and fuel lines.

10. Drain the chaincase lubricant, but always reinstall the chaincase cover with seal, and pour in new chaincase lubricant.

11. Remove the drive belt and lay it on a flat surface or slide it into a cardboard sleeve for storage.

12. Clean and inspect the drive clutch and driven clutch.

13. Apply oil to the steering post bushings, ski spindle(s), and the front and rear arm-pivot bushings of the skid frame.

14. Tighten all nuts, bolts, and screws making sure all are torqued to manufacturer's specifications.

15. Inspect all rivets and replace loose ones.

16. Clean and polish the hood, console, and exterior.

17. Raise the track off the floor by blocking up the back end and make sure the snowmobile is secure on a safety stand.

18. Loosen adjectment bolts to loosen track tension.

19. Cover the snowmobile with a machine cover or heavy tarpaulin.

☐ Have your instructor check your work.

20. Clean up area and return tools and materials to proper storage.

STORAGE
UNIT XIV

NAME ______________________

TEST

1. Match terms related to storage with their correct definitions.

_____a. Moisture in the air

_____b. The process of filling the engine with an oil and air mixture to protect it from corrosion during summer storage

_____c. The formation of gum in the carburetor from the residue of fuel and oil

_____d. A wax product used to give the chassis of a vehicle a high luster and protection from the elements

_____e. An additive to the fuel/oil mixture which helps protect the engine and internal parts from corrosion

_____f. Any chemicals sprayed or applied to the internal engine components to protect the engine from rust

1. Fuel conditioner
2. Varnishing
3. Fogging
4. Engine corrosion inhibitors
5. Polish
6. Humidity

2. Select true statements concerning cleaning by placing an "X" beside each statement that is true.

_____a. Corrosion and rust probably damage more snowmobiles in summer storage than in winter use.

_____b. Foreign material, dirt, grime, grass, and oil which collects on a snowmobile during winter use can serve to attract and hold humidity which causes rust.

_____c. An essential procedure to prevent rust during summer storage is to clean the entire snowmobile thoroughly of all lubricating material.

_____d. A thorough washing is required under the seat cushion, in the tunnel, the skid frame, hood and belly pan, as well as the track and suspension system.

_____e. The snowmobile must not be allowed to dry thoroughly before storage.

_____f. Always use an available automotive-type polish, or one recommended by the snowmobile manufacturer, to wax the hood, console, and exterior.

TEST

3. Complete statements concerning engine preparation by circling the word(s) that best completes each statement.

   a. The (**engine, skis**) is the part of the snowmobile most vulnerable to damaging corrosion and must be thoroughly protected during summer storage.

   b. Manufacturers may differ on whether or not to drain the fuel tank, but the carburetor and (**oil, fuel**) pump should be drained.

   c. Many manufacturers agree that fogging (**is, is not**) necessary to prepare the engine for summer storage.

   d. The fogging procedure has been (**complicated, simplified**) by the production of special fogging sprays which are commercially available.

   e. Fogging often causes a fog in the air surrounding the snowmobile, and can be a (**nuisance, health hazard**).

   f. Engine bearings are the (**least, most**) susceptible to the harmful effects of corrosion.

   g. A byproduct of the ignition of the fuel-oil mixture is (**alcohol, water**), so manufacturers recommend not starting the engine during summer storage.

   h. In addition to fogging, manufacturers recommend that engine (**oil, corrosion**) inhibitors be used in the engine as a part of storage preparation.

   i. If fogging is not used for preparing the engine for storage, an alternative to fogging is to inject light engine oil into each (**engine port, spark plug hole**).

   j. When the oil injection method is used, turn the engine over several times to distribute oil throughout the engine and be sure to replace the (**spark plugs, fuel tank cap**).

4. Select true statements concerning battery preparation by placing an "X" beside each statement that is true.

   _____a. Before storing a snowmobile, the battery should never be removed from the chassis.

   _____b. Always inspect the electrolyte level in the battery and add distilled water if necessary.

   _____c. Always inspect the terminals of the battery before storage to make certain they are clean and bright.

   _____d. Store the battery in any dark, cool place.

   _____e. Check the battery at intervals to make sure it keeps a full charge.

TEST

5. Select true statements concerning drive train preparation by placing an "X" beside each statement that is true.

   _____a. As a preparation for storage, always remove the drive belt, and mark the direction of travel.

   _____b. The drive belt should be flat during storage to prevent warpage.

   _____c. As protection against corrosion, some manufacturers recommend that a light oil be lightly applied to all clutch sheaves.

   _____d. The track tension should always be loosened in preparation for storage, and the track should be stored on a wooden floor.

6. Complete statements concerning lubrication and storage by inserting the word(s) that best completes each statement.

   a. Some manufacturers recommend that a thin film of a light ____________ be applied to the bottom of skis, ski pivots, and steering spindle bushings.

   b. Some manufacturers recommend that ____________ oil be drained from the system and replaced with petroleum-based oil because ____________ oil will not adhere to engine components as well as petroleum-based oil.

   c. Make a final inspection of all bolts, nuts, screws and rivets to make certain they are ____________.

   d. If a snowmobile is to be stored outdoors during the summer months, it should be completely covered to protect it from ____________ and ____________.

7. Solve problems concerning removing a snowmobile from storage.

   a. What is an alternative to installing the old drive belt after summer storage, and what benefit would the alternative offer the operator?

      Answer ____

      ____

   b. What is the procedure for proper adjustment of track tension and alignment after summer storage?

      Answer ____

      ____

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

8. Solve problems related to snowmobile storage. (Assignment Sheet #1)

9. Demonstrate the ability to prepare a snowmobile for summer storage. (Job Sheet #1)

STORAGE
UNIT XIV

ANSWERS TO TEST

1. a. 6
   b. 3
   c. 2
   d. 5
   e. 1
   f. 4

2. a, b, d, f

3. a. Engine
   b. Fuel
   c. Is
   d. Simplified
   e. Health hazard
   f. Most
   g. Water
   h. Corrosion
   i. Spark plug hole
   j. Spark plugs

4. b, c, e

5. a, b

6. a. Oil
   b. Synthetic, synthetic
   c. Tight
   d. Dust, moisture

7. a. Install a new belt and use the old one as a spare
   b. Adjust tension and alignment, start the engine and permit the track to rotate at slow speed, and stop the engine and make the tension and track adjustments a final time

8. Evaluated to the satisfaction of the instructor

9. Performance skills evaluated according to procedures written in the job sheet